MACHINERY.

November, 1903.

MACHINE SHOP EQUIPMENT.—3.

PLANS FOR THE DRAWING ROOM AND ITS EQUIPMENT.

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Brains are more important than hands; ideas are more sought after than things; the conception of that which we are to do, of that which we are to develop or to build, to produce and to sell, are first in the natural order of conducting all manufacturing operations, or of entering into any line of the world's trade and commerce. The *plan* is the first and important matter, and to plan well and wisely we must have the best ideas obtainable. These ideas and conceptions have many and far-reaching results and consequences, both as to a matter of mechanical and of financial success. Good ideas, properly developed and elaborated, may mean the beginning of years of business success to the owners or the promoters of the enterprise; while defective and ill-considered plans may mean practical ruin or thousands of dollars wasted in fruitless work.

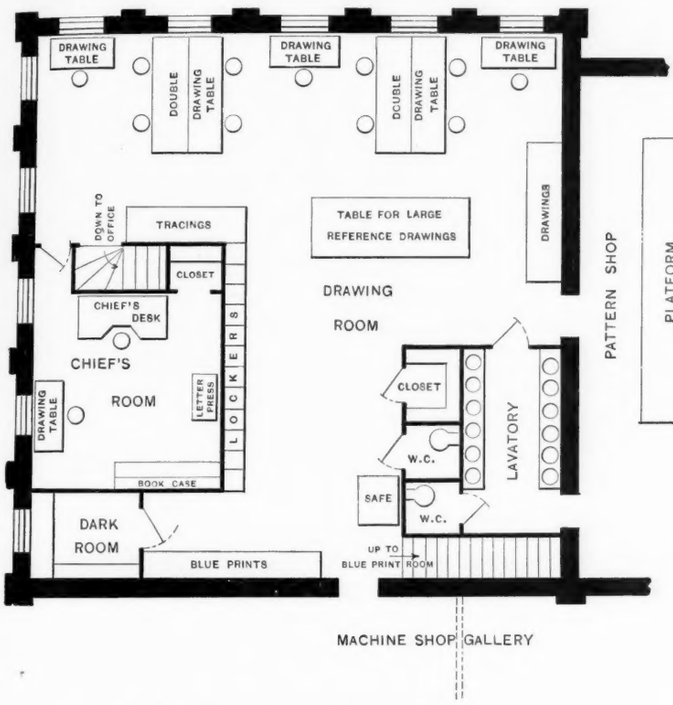

Fig. 1. Drawing Room and its Arrangement.

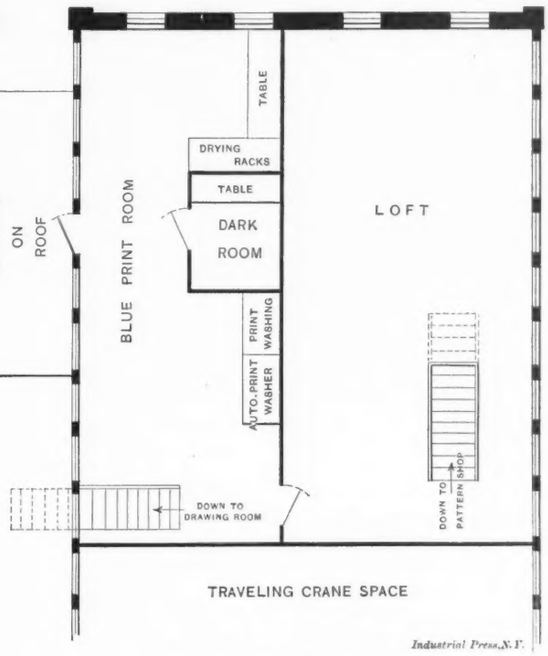

Fig. 2. Blueprint Room.

But to plan well, to bring out the best ideas of the men whose duty in life is to study and think and plan the work that others are to perform, men should be placed in proper and congenial surroundings, which may inspire them to conceive and bring out the very best ideas of which they are capable, just as in any other line of human effort we make the conditions as favorable to success as we can if we are to expect good results.

The drawing room of the machine shop has often been facetiously called "the brain room," by those who have little conception of its real usefulness in the manufacturing establishment. Yet this is precisely what it should be, if it is properly organized, equipped, and has the right quality of men in its working force. And nowhere in the whole establishment is there more need of men of original thought; of men with ability to "see the point," to grasp the situation and make practical use of ideas and suggestions as they present themselves; and to take apparently worthless plans or devices and develop them into that which is mechanically good and financially profitable. These conditions making the drawing department one of the most important in the whole establishment, it naturally follows that in its location and equipment much thought and care should be exercised so that all the conditions and surroundings should be of the best, as to their kind and their adaptation to the particular class of product which the establishment is to turn out. By this we do not mean that the drawing room should be expensively or luxuriously fitted up. Its design may be comparatively plain and yet architecturally and artistically correct and agreeable. Its furniture may be simple and yet appropriate, and serve its purpose as well as that costing several times as much. Dark-colored woods should not be used owing to the fact that their color absorbs so much light. We should choose, rather, light-colored woods such as oak, ash, birch, or even white pine varnished, according to the amount available for the work. The walls may be wainscoted or sheathed up to about the height of the tables, but above this line they should be finished with a plain, white surface. The ceilings should also be white. A hard finish of what the plasterers call "adamant" is very durable and may be rendered still more so by painting with oil paint, several coats of which should be put on, in preference to kalsomining.

The windows should extend from the height of the drawing tables entirely to the ceiling. They should be provided with two curtains, one reaching from the top of the window down to the center, and a second one reaching from the center down to the bottom. The men working directly in front of the windows should only handle the lower curtain; and those in the center of the room have charge of the upper curtain. The curtains should be white, or nearly so. Instead of curtains some prefer ribbed glass, as it does not admit a glaring light in any one place, but is very useful in diffusing the light over the whole room, and the appearance

of the room is much better than where curtains are used. Some prefer plain glass for the lower portion of the window and ribbed glass for the upper portion.

Electricity is the favorite artificial light, and the incandescent lamp seems to be the proper one. The question of whether we shall use enough of these, placed high up, to flood the whole room with light, or have them low down and

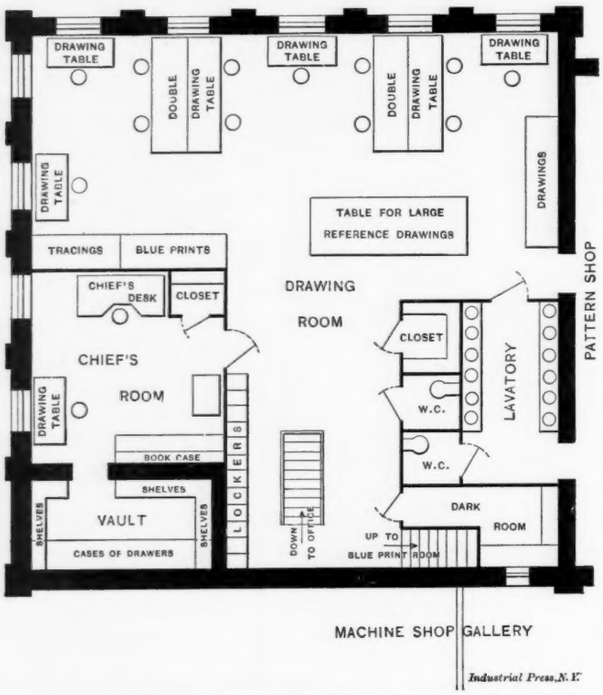

Fig. 3. Drawing Room Arranged for Storage Vault in one corner.

under the control of each individual, is still discussed with fairly good reasons on both sides. Probably a majority of draftsmen will prefer the individual lamps which they can place in any position best calculated to aid them in the particular kind of work in hand.

Some of the more important conditions in reference to the location and construction of the drawing room are these: It should be away from the noise and bustle of the machine shop, yet near enough to make the latter readily accessible. It should be directly connected with the pattern shop as it is so intimately associated with it in many of the preliminary operations. It should be readily accessible from the offices. It should have plenty of fresh air and be well ventilated at all seasons of the year. In winter the heating system should be such as to maintain as even a temperature as possible. It should be well lighted, by natural light by day, and a proper artificial light during the hours which make it necessary. It should be provided with proper facilities for photographing machines, or any of the articles produced by the shops. It should have connected with it, but not installed in it, facilities for blueprinting, where an abundance of light is available at all hours of the day. It should be provided with proper facilities, not only for making drawings and tracings, but for indexing them, for issuing and receiving them, and for safely preserving them from fire or other injury. In the descriptive matter which follows and the drawings illustrating it, the effort has been made to meet all of these conditions in a practical and economical manner, and on such a plan as will provide drawings, tracings, blueprints, etc., for small or large plants, or for a large variety in the product to be manufactured; as will be pointed out in detail later on in this article.

In the drawings, Fig. 1, is a plan of the drawing room, located above the offices and well lighted by ten large windows, as shown. It is reached from the latter by a broad flight of stairs. Along the front are located the drawing tables, providing for eleven draftsmen. The arrangement is so made that three of the single or regular tables are for the draftsmen making the general drawings, their tables facing the windows. Between them the two double tables are placed, with their ends toward the windows. These tables accommodate four men each, who do the detail work and the tracings. The circles in front of the tables indicate the positions of the men.

The single drawing tables are shown in perspective in Fig. 5. These are of the plainest construction consistent with usefulness. The top inclines one inch to the foot, and is three by six feet, which is ample for most general drawing work. They may be made with vertical legs, but the crossed legs here shown are more rigid. Braces extend from the crossing of the legs to the center beneath the drawers, to support the top as well as to act as braces to insure stiffness. Foot rests are provided, ten inches from the floor. The height of the tables in front is thirty-seven inches. Three drawers are supplied for holding instruments, books, memoranda, etc.

Many more or less complicated forms of drawing tables as well as other equipments for the drawing room, have been devised, described, illustrated, built, used, and in many cases discarded; and it has come to be the opinion of many of the older draftsmen that while each of the more complicated devices has its peculiar merits, the simpler forms are, in the long run, best adapted for every-day work. The double drawing tables are shown in Fig. 6. They are six feet by ten, and are the same height and inclination of top as the single tables. Three drawers are provided for each draftsman, and a convenient shelf is placed over the center, within the reach of all the men, for holding instruments and many small articles that it is desired to place out of hand but within reach. Foot rests are provided the same as in the single tables. These tables are of the proper height to permit the draftsmen either to sit or stand at their work, as a change of position is much easier than maintaining either one of these positions for hours at a time.

The chief draftsman has a separate room and he is provided with one draftsman whose duty will be that of working

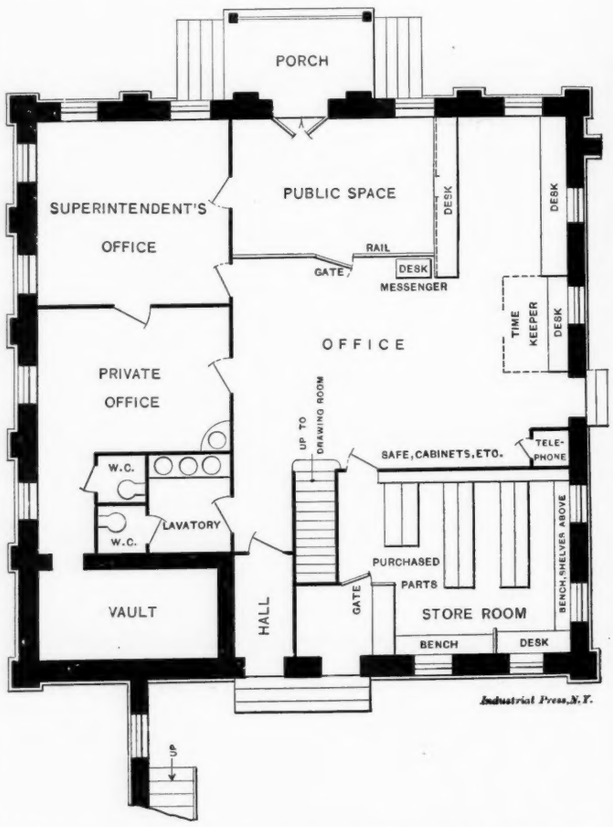

Fig. 4. Arrangement of Offices under Drawing Room, when there is a Vault.

out special devices that come more particularly under the constant supervision of the chief. The desk of the chief is shown in Fig. 7, and is identical with one used several years by the writer and found to be a very useful and practical desk and drawing table combined. The top is thirty inches

high, and thirty-four inches wide by six feet long. The center of the top at the front is cut out in a semicircular or hexagonal form of a recess to enable the draftsman to sit

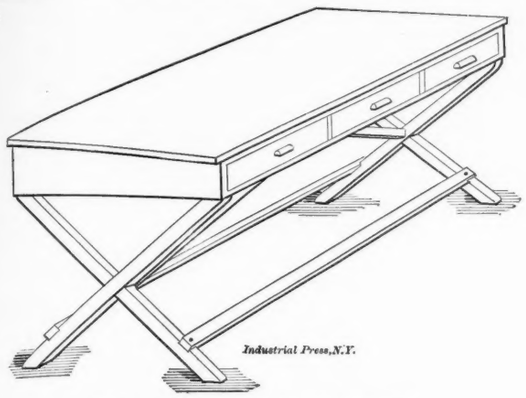

Fig. 5. Drawing Table for one Draftsman.

in close to his work and at the same time to have ample table room at the right and left. Two boards drawing out under the top, one at each side, add to this space, so that a practically continuous table on three sides of the draftsman is provided. This arrangement is very useful where many reference drawings, books or catalogues are to be consulted. Four drawers on each side and one directly in front furnish ample filing space. A shelf at the back is convenient for books or for supporting instruments or other small articles not in use at the moment. The chief's room is provided with a convenient closet, and it has a table with drawers beneath and a bookcase above, as well as a letter-copying press for making letter-press copies of sketches, memoranda and similar matter sent into the shop or to those outside of it. The drawing table used by the chief's assistant is the same as the single tables in the large room.

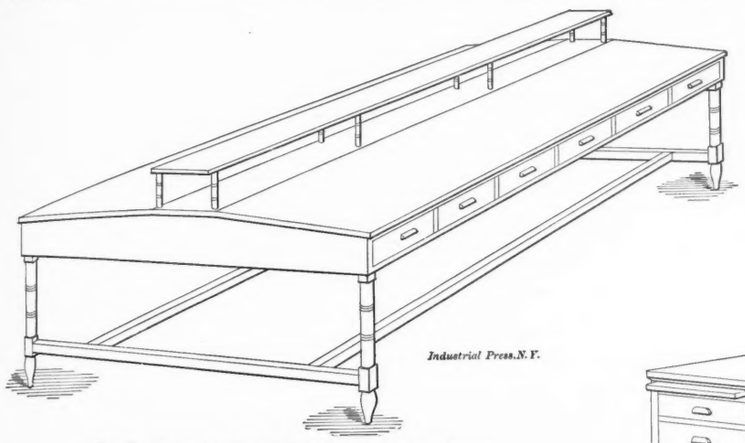

Fig. 6. Double Drawing Table for Detail Draftsmen.

In Fig. 8 is shown a very convenient filing case for drawings. It has drawers for general drawings and detail drawings, made of different sizes to suit their dimensions. These drawers should have a fixed horizontal strip, say ⅜ inch thick and 5 inches wide, running along the back of the drawer at the top, to prevent drawings from curling up and sliding over the back edge of the drawer. In the front part of the drawer a similar strip, pivoted, or hinged so as to turn down over the front edge of the drawings, or back out of the way when the drawings are to be examined, removed or replaced, will be found very useful. In the center of the front each drawer should have a metal label holder, in which a lettered card, readily removed and changed when necessary, describes the contents of the drawer. Usually each drawer is devoted to the drawings of one machine. Above the table are two cases in which are to be kept rolls of drawing paper of different widths or qualities, tracing cloth, tracing paper, etc. Doors hinged at the top and provided with spring catches at the bottom, afford convenient access. The ends of the rolls of paper are brought down at the back and out the front under a guide bar, as shown, and along a sliding scale-of-inches, let into the top covering the drawers, and by which any length or width of sheets are measured, and may be cut off with a knife guided by the guide bar. So far as we know, this is the most practical and convenient method of keeping and cutting up drawing papers; and the plan of purchasing drawing paper in rolls and cutting it up into any desired size of sheets seems to be preferable to purchasing the paper in sheets of odd sizes and trimming it to the dimensions required. In the center, between the two drawing paper cases, are shelves for holding books, catalogues, etc. This case is located against the wall dividing the drawing room from the pattern shop, and convenient of access for the draftsmen.

At the opposite side of the room, and against the stationary partition, is the case for filing tracings; and against the wall next to the machine shop a similar case is used for finished blueprints. It is of the form shown in Fig. 9, and has drawers constructed in the same manner as those in the case for drawings shown in Fig. 8. It is built higher than the latter to increase its capacity, although, of course, it may contain any number of drawings required for the work.

Many systems for filing and preserving drawings, tracings and blueprints have been devised, but here again, simplicity will be found best in practice, and by devoting one drawer to each machine and properly indexing the drawings and tracings, the desired sheet may be quickly found, taken out and replaced, with little disturbance to the others. Where the variety of the work makes it necessary to have a great num-

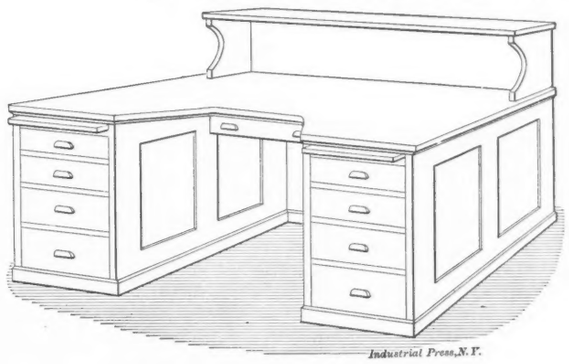

Fig. 7. Chief Draftsman's Desk.

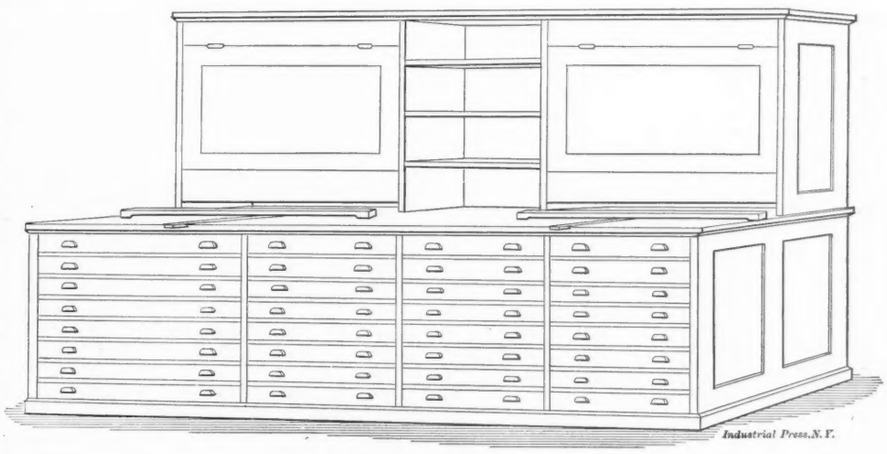

Fig. 8. Case for Filing Drawings and Tracings.

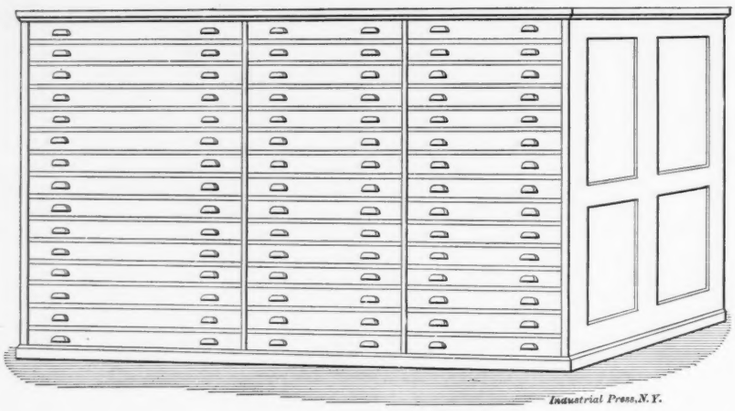

Fig. 9. Case for Filing Blueprints.

ber of classes it will be found that a more elaborate system is needed, but the plan proposed will be sufficient for a large majority of establishments. In filing tracings it is well to lay in a sheet of thin straw board between every ten or twelve tracings, or to divide the tracings of a machine into divisions representing the groups of parts of the machine, as, for instance, of a lathe, the headstock, tailstock, carriage, apron, etc. This helps to keep the tracings lying flat without wrinkles and aids in quickly finding the one needed.

In the central space of the room is a table five feet by fourteen, for large reference drawings and similar purposes. Drawers under this table are convenient for holding large construction sheets which cannot be filed in the regular cases without folding.

Against the partition of the chief's room is a row of lockers, one for each man. These should never be constructed of boards, or in any way tightly enclosed, but, as a matter of fire protection and sanitary cleanliness, should be open to a free circulation of air; and nothing which we have seen fulfills the conditions better, or perhaps as well, as what is generally known as the "expanded metal" used in many establishments for this purpose.

The above arrangement of the drawing room and its equipment is intended for cases where there does not seem to be the need of an expensive vault in which to store drawings, tracings, blueprints, etc. Still the want of this means of safety to such valuable records in case of fire has of late years been gaining in importance and would seem, in most cases perhaps, a good investment from the point of view of insurance. Hence an arrangement of the plans of both offices and drawing room has been made with this end in view, and is shown in Figs. 3 and 4. As a matter of economy the vault is built in a corner of the structure, the walls of which form two of its sides. For this purpose the superintendent's

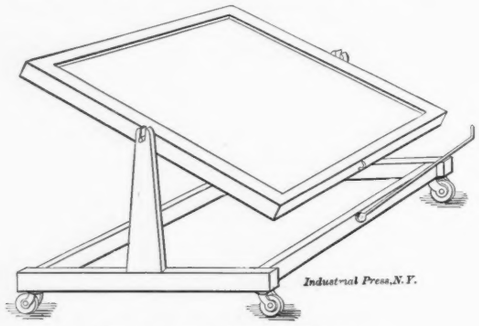

Fig. 10. Large Blueprint Frame.

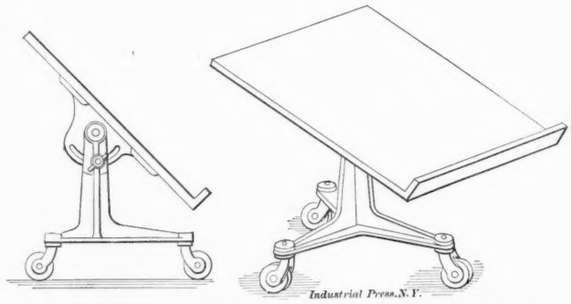

Fig. 11. Fig. 12. Stand for Supporting Blueprint Frame.

Next to the chief's room a dark room is provided for photographic work, as every modern drawing room is expected to be able to make photographs of machinery and similar articles; and this branch of work should not be done in connection with blueprinting, owing to failures that may result from carelessness in handling the necessary chemicals.

In the opposite corner of the drawing room and next to the pattern shop is arranged a lavatory provided with twelve bowls for the use of the draftsmen and patternmakers. In connection with this are two water closets, one of which

public and private offices are placed next to each other and the lavatory located between the latter and the vault, while the stairway leading to the drawing room is placed between the hall and the "Purchased Parts" store room. This permits the vault in the drawing room to be built directly over the one in the offices and next to the chief's room, out of which it opens, without disarranging the plans to any considerable extent. The dark room is placed under the stairs leading to the blueprint room. The vault is provided with cases of drawers similar to those in the drawing room, and with racks for

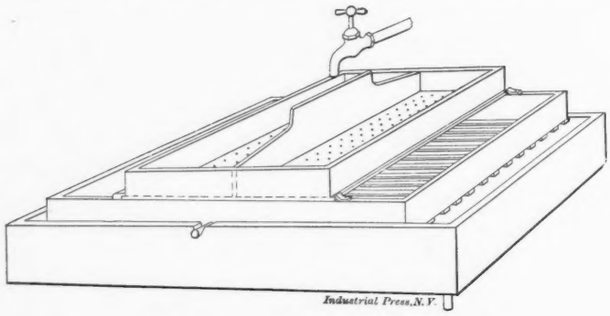

Fig. 13. Automatic Washer for Blueprints.

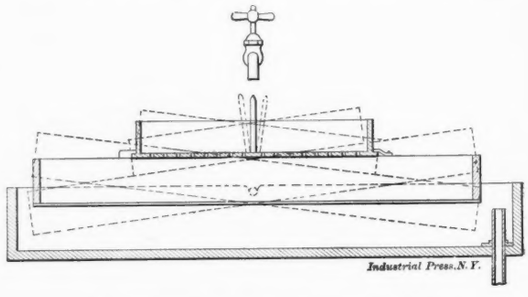

Fig. 14. Cross Section of Automatic Washers.

opens out of the lavatory and is used by the patternmakers; the other opening from the drawing room is for the draftsmen's use. A large storage closet is included in the space devoted to the above purposes and between this space and the rear wall is the stairway leading to the blueprint room above. A fire-proof safe of sufficient size should be provided for storing such records and original drawings of special devices as cannot be readily replaced, and such valuable papers as always accumulate in the drawing room.

holding negatives, as well as shelves upon which may be stored any valuable records, memoranda and similar articles. These vaults are eight feet wide and sixteen feet long, and have masonry floors and brick arches overhead. The walls should be sixteen inches thick, exclusive of an air space of 1½ inches in the center of the walls. Steel should not be used in their construction unless it is completely covered by brick work, on account of its tendency to warp from the excessive heat of a fire. Double fire-proof doors should be provided,

similar to those used in safes. The hinges should be held by bolts passing entirely through the walls, as should also be the case with bolts securing the door frames.

The blueprint room is located in the monitor roof in the center of the building, and thus over both the drawing room and the pattern shop. The space available is eighteen feet wide. It is well lighted along one side and across the front end. In it are built a large dark room and other facilities and appliances for print washing and drying, as is shown in Fig. 2. The blueprint frames are opened and filled in the dark room and the smaller ones carried out the door to a platform built over the roof and on a level with the floor of the blueprint room. Instead of being supported by any kind of a rack, they are placed upon an adjustable blueprinting stand, as shown in Figs. 11 and 12. This may be easily turned to face the sun and the supporting board adjusted to whatever altitude the sun may happen to be at the time. The stand

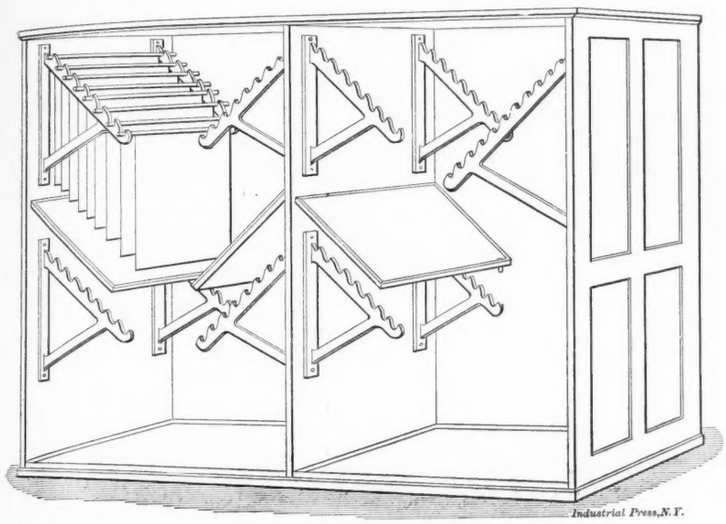

Fig. 15. Blueprint Drying Racks.

is made with a cast-iron standard rising from the base which is supported on three caster wheels of not less than three inches in diameter. A cast-iron support is pivoted between jaws formed in the standard, to which it is clamped in any desired position by a bolt and hand nut, as shown in Fig. 11. The board is attached to this support. When in the room the board may be brought to a nearly vertical position, thereby occupying less space. These stands may be kept in the room and the boards placed upon them and rolled out on the platform, if heavy printing frames are used, but this is not usually necessary.

Fig 10, shows a device for supporting large printing frames. This rests on four caster wheels of not less than four inches in diameter. Trunnions are fixed on the sides of the printing frame in a position to exactly balance it, and either the collars of these trunnions should press tightly against the standards, or the trunnions should be considerably larger than those shown, so that the friction will hold the frame in any desired position for printing. The printing frame may be held in a horizontal position for filling by means of the rod pivoted at one end of the frame and having at the other a hook formed upon it which engages a staple in the end of the frame. When in use this frame is rolled to the door of the dark room, the tracing and blueprint paper put in, closed up and rolled out on the platform, thus avoiding much of the usual manual labor in carrying heavy printing frames. Where printing must be done out of a window various forms of tracks and frames must be resorted to, but there are many advantages in so locating the blueprint room as to utilize the roof for supporting a large, level platform, as here described. In cases where no monitor roof or similar facilities are offered, and the roof is nearly level, or with a slight pitch, it will be best to build a printing room on the roof with a platform outside of it, so as to be operated as here described.

A simple washing box is provided for soaking blueprints in the usual way. Also, an automatic print washer, as shown in Figs. 13 and 14. In this device a fixed box has pivoted in it a smaller box, whose bottom is composed of light slats. Upon this box is attached, but so as to be removable, a smaller box with a perforated bottom and divided by a transverse partition set exactly in the center. The operation of the device is as follows: The top box being removed by turning the buttons securing it, the blueprints are laid upon the slats, as many as six or eight at a time, and the top box replaced. The water is turned on at the faucet and one end of the pivoted box is depressed to either of the positions shown by dotted lines in Fig. 14, which will throw the water into the compartment at the higher end of the smallest box. A considerable portion of the water will trickle through the small holes of the top box and upon the blueprints, while the opposite ends of the prints are immersed in the water of the lower box, which is maintained at a constant height by the overflow pipe, as shown in Fig. 14. The perforations in the bottom of the top box not being sufficient to carry off all the water, it gradually fills up that compartment and the pivoted box, thus weighted, is depressed, and the water from the faucet flows into the other compartment and the operation is repeated. The frequency of this rocking movement is easily regulated by the amount of water that flows from the faucet. The operation is not only entirely automatic, but very thorough in its action, as the prints lying upon each other are separated and the upper ones float whenever that end is depressed into the water. The water constantly flowing in and out of the lower box readily eliminates the chemicals that are to be washed out of the prints. So far as he knows, the writer originated this method for washing blueprints and photograph prints and used it with much satisfaction. The boxes may be made of wood and kept well painted; or may be of galvanized iron or zinc protected by paint. The original one was made of white pine, the lower box of 1¼ inch, the pivoted box of ⅞ inch and the top one of ½ inch stuff, and painted with white lead.

For drying blueprints various devices have been used, but so far as the writer knows, nothing is more economical or better adapted to the purpose than the drying case shown in Fig. 15. The plan is to attach the blueprints to small, round sticks by means of small wooden spring clips and hang them on supporting brackets. The brackets are of light cast-iron or wood, as may be preferred, and should incline on an angle of 45 degrees, so that any print may be conveniently reached and removed without removing those in front of it. Two pairs of these brackets are located, one above the other, for medium-sized prints, say 18 x 24 inches, as on the left of the engraving, or one pair for large prints, as shown on the right. The upper section of prints drip the water into a zinc tray supported by a wooden shelf fixed at an angle of 45 degrees, from the lower corner of which, at the back, a short pipe carries the water into a similar tray resting on the floor, and from which suitable pipes carry the water to the waste pipes coming from the print-washing apparatus. The drying of blueprints may, of course, be hastened by the application of artificial heat. For this purpose doors may be added to the drying case and a small steam coil be placed in the bottom or near the back of the case. But to use artificial heat, or any temperature over about one hundred degrees has a tendency to cause the prints to be distorted by unequal shrinkage, and marred by wrinkles, while drying them by the natural temperature of the room, and suspended as in this case, will cause them to come out in good condition.

To adapt this plan of constructing and equipping a drawing room to the wants of larger establishments requiring a larger force of draftsmen it is only necessary to extend its length so as to provide for a greater number of the single and double drawing tables, to any extent required. The capacity for filing drawings, tracings and blueprints should be increased in proportion. One or more large tables for reference drawings will be needed, and the number of lockers increased to accommodate the added force of draftsmen.

Otherwise the same arrangement of the plan need not be disturbed, as the chief's room, photographic dark room, vault and all the other accessories will be either ample, or very easily adapted to an increase to any reasonable extent that may be desired.

* * *

LET US FIRST LEARN TO FLY.

"I wonder if the inventors who are worrying their brains over the solution of the problem of aerial navigation ever give the legal side of the subject a thought?" said an attorney to a New York Tribune reporter. "Probably not, and probably few lawyers have ever thought of their profession in connection with flying through the air; and yet, if we assume that the means of locomotion through the air are equally perfect with those on land and water, it becomes evident at once that there will have to be considerable new legislation to protect both the public and those who engage in transporting passengers and freight through the air. One of the first problems to be settled will be the question of the right of way.

"Would an aerial line passing over a definite course, at whatever altitude, be a nuisance to an owner of subjacent land, and therefore entitle him to damages for the injury or to compensation for taking of his property? If not, then at what proximity would traffic begin to infringe on his rights? These are important questions and would have to be settled by the lawmakers before a chartered company could run an air line between any two points.

"It might be that the aerial navigators could be sued for trespass, as the common law looks upon the ownership of land as extending to the sky. Consequently a statutory law would have to be passed abrogating the right of the property holder under the common law. Then, too, there is the danger of something falling from the airship, or sky train; and if any loss of life should ensue, or there should be any damage to property, the law must be so framed that the property holder could recover adequate damages. In such an accident it would be difficult to prove contributory negligence."

NEW SHOP OF THE CINCINNATI SHAPER CO.

The great development of the machine tool industry in Cincinnati within the past few years, has, as every one knows, been quite generally along the lines of specialism, most of the makers of this class of machinery in the "Queen" city confining their product to one type of machine tool only. While this tendency has by no means been confined to Cincinnati, this city probably has more shops conducted on these lines than any other. In the census report for 1900 the tendency toward specialism is commented on, from which the following statement is taken:

"This tendency has prevailed in Cincinnati, perhaps, more than in any other city, and has been one of the characteristic features of the rapid expansion of the machine tool industry in that city during the past ten years. During the census year there were in Cincinnati thirty establishments devoted to the manufacture of metal-working machinery, almost exclusively of the classes generally designated as machine tools, and their aggregate product amounted to $3,375,436. In seven shops engine lathes only were made, two (?) were devoted exclusively to planers, two made milling machines only, drilling machines formed the sole product of five establishments, and in three shops shapers only were made. Several other manufacturers made only two or more of these classes of tools, but for the most part the industry was very strikingly specialized."

Fig. 1. Interior View of Cincinnati Shaper Co.'s Shop, showing Clearstory Roof Construction, Hand Traveling Cranes, etc.

The Cincinnati Shaper Co., as the firm name denotes, is one of the machine tool specialists referred to, its product consisting solely of crank, geared and traverse shapers. In 1902 the firm erected a new shop in the machine tool district that now stretches along Mill Creek Valley from Eighth Street to Winton Station, and has occupied it since about the first of this year. The shop is of the three-bay, clear-story or monitor roof construction and, of course, is typical of the large class of modern machine shops built along these lines to secure traveling crane facilities and good light. It is a shop, however, that should interest concerns building machinery up to, say, 15 tons (which is the weight of their heavy traverse shapers), who desire a moderate-size shop built with a conservative regard for cost, convenience and efficiency.

The new shop is located on a plot of land 389 x 415 feet, on Beard and Elam Streets, just off Colerain Avenue, and is near the tracks of the B. & O. S.-W. and Big Four railroads, from one of which a switch will eventually be laid to it. The plan is shown in Fig. 2. The total length is 290 feet 10½ inches, and the width, 92 feet 10 inches. A wing was erected at about the middle of the north side for the engine, generator and boiler, and it also contains a wash room, locker room and

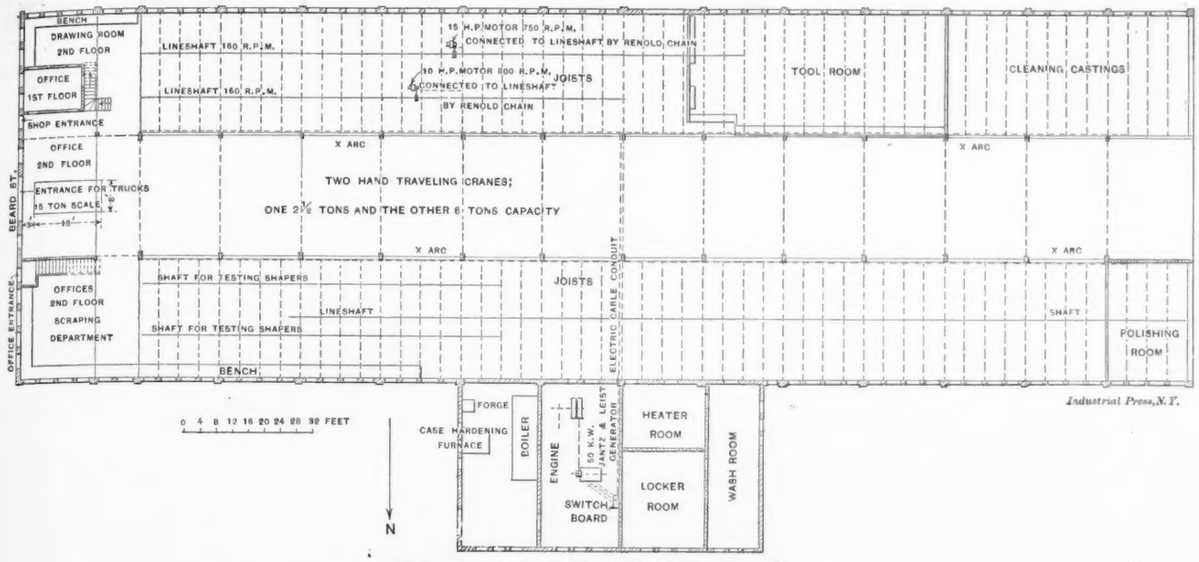

Fig. 2. Ground Plan of Cincinnati Shaper Co.'s Shop.

compartment for the shop heating apparatus. A forge and casehardening furnace are located in the boiler room. The engine is belted to the main lineshaft in the north bay, which is about 220 feet long. The two testing lineshafts, each 90 feet long, are driven by the main lineshaft through belts and friction clutch pulleys. The engine is also belted to a Jantz & Leist 50 K. W. generator which supplies the lighting circuit and the power circuits for the south bay. The electric cables for this section are carried in a conduit under the

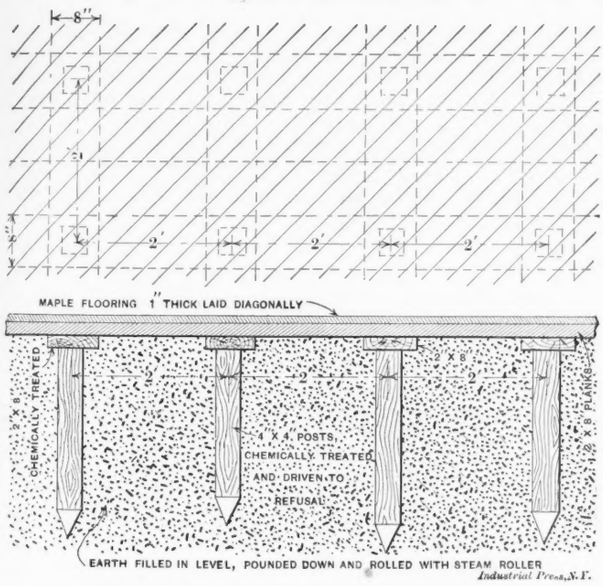

Fig. 3. Details of Foundation and Floor Construction.

floor so there is nothing to interfere with the free movement of the traveling cranes along the full length of the erecting floor.

The best floor for a machine shop is a problem that has puzzled many builders, and perhaps the solution has not yet been reached. But where lumber is comparatively cheap there seems to be nothing yet used that equals it in the matter of cost and general utility. It is not badly damaged by ordinary falls of machinery parts, and the parts themselves do not usually suffer. It is comfortable to work on, and when repairs become necessary they are easily made. The floor of this shop is made of one-inch maple, laid on two-inch planks which are supported as shown in the detail, Fig. 3. The ground was first filled in some parts to a depth of 18 inches to make the surface level. The earth was pounded down and then rolled by a steam roller until it was as solidly compacted as it could be made, mechanically. To support the floor, 4 x 4 inch stakes, sharpened, were driven to refusal with heavy mauls, and the tops sawed off level. Upon each row 2 x 8 inch planks were laid flat and spiked fast, to support floor proper. Both these planks and the stakes were chemically treated to prevent rotting. The stakes were spaced 2 feet apart, center to center, in both directions. Upon and across the planks supported by the stakes, the floor planks were laid and on top of these the maple floor was laid diagonally. The machines are set directly on this floor, save some of the heavier tools which have concrete foundations, notably three Cincinnati No. 4 milling machines, upon which some record performances have been made.

A 15-ton platform scale, 8 x 18 feet, is located in the floor at the street entrance, on which castings brought on trucks can be weighed in bulk. The location of this scale will probably be changed to the opposite end of the shop when the railroad switch is laid, as then the castings will generally be delivered by rail. The plan of the shop and the location of the tools were designed with this condition in view, the casting cleaning department being at that end of the shop as well as the rough and finished material stock rooms. The locations of the machine tools determine the route of the various parts and, as stated, these have been laid down so that stock taken from the material stock room shall traverse its appointed course and return to the finished stock room with the least handling. From thence the parts required for the erection of each shaper are loaded on special trucks, one set only on a truck, and transported to the erecting floor. Of course an exception is made in the case of the heavy parts such as the frames, knees, etc. In connection with the stock room, the plan of keeping track of rough and finished castings is worth noting. Two blackboards, say 4 x 4 feet, are mounted in two pairs of vertical guides, back to back, and connected together by means of ropes running up over pulleys so that one counterbalances the other. When one board is down, the other one is up out of the way, making both sides of each board available for keeping accounts. One board is used for rough castings, and the other for finished stock. They are ruled vertically, two adjacent columns being headed "Patterns" and "Stock" respectively. Following the pattern numbers the number of pieces in stock are written in the column headed " Stock."

As intimated in a preceding paragraph the machinery in the south bay is motor driven. Two lineshafts have been

erected, one being about 150 feet long, and the other 120 feet. The longer one was driven by a 15 horse power motor, and the shorter by a 10 horse power motor. Both are connected to the lineshafts by Renold chains. This installation is an instructive example of the great disparity in motor horse power required for individually-driven tools and group-driven tools.

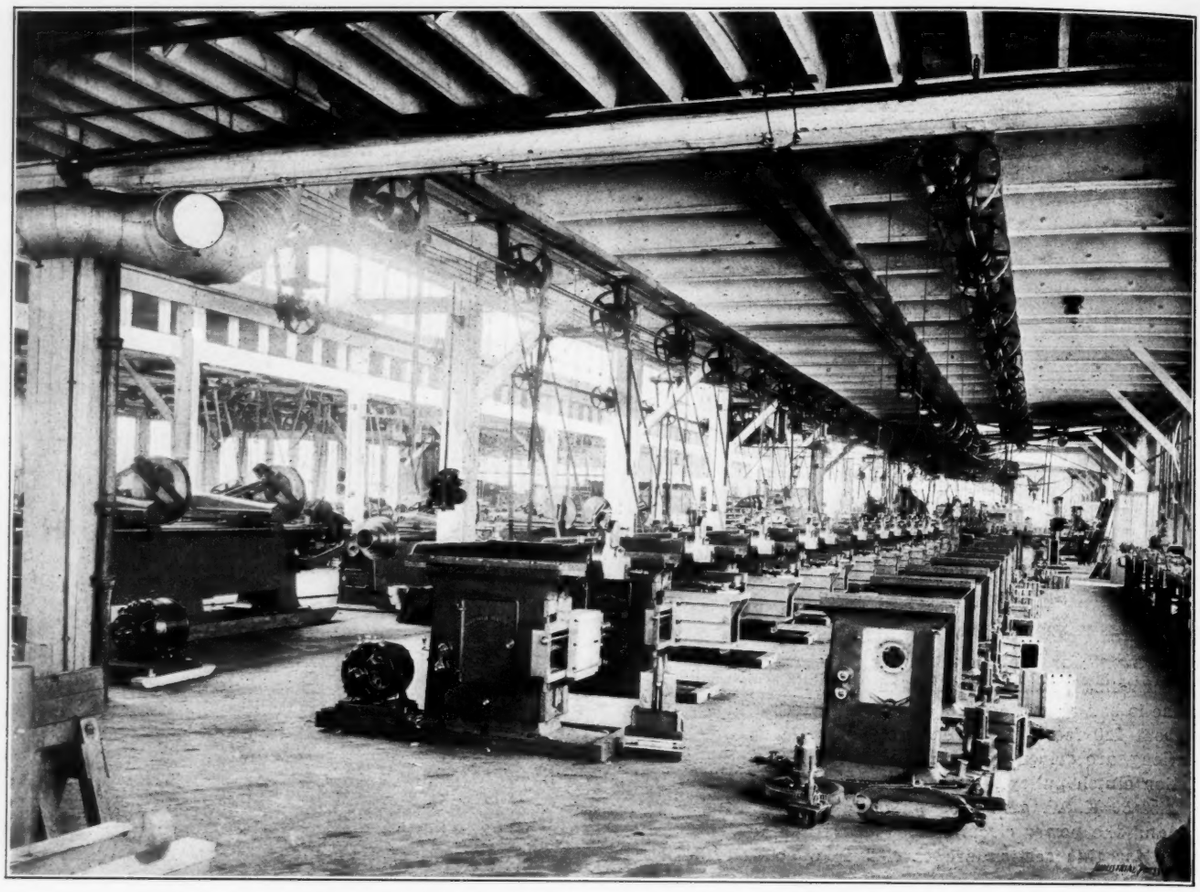

Fig. 4. View from Northeast Corner, showing Shaper Testing Department.

Lineshaft *A*, Fig. 5, drives 12 machine tools; and lineshaft *B*, 19 tools. The maximum power required for each tool was carefully estimated from available data, and the actual power requirement for each group was estimated to be not more than fifty per cent. of the total at any time. Most of the time it was expected that the percentage of power would be still less. The following table gives the estimated maximum power requirements for each group:

LINESHAFT A.

Number of machines.		Estimated H.P.
3	No. 4 plain milling machines, total	6
1	20-in. lever drill	1
1	20-in. chucking lathe	2
1	Jones & Lamson lathe	2
2	25-in. lathes, total	4
1	18-in. lathe	1¾
1	16-in. shaper	1¾
1	Cut-off saw	1
1	Centering machine	½
12	Total	20

LINESHAFT B.

Number of machines.		Estimated H.P.
1	30-in. gear cutter	1½
2	No. 3 plain milling machines, total	3
1	No. 2 Universal milling machine	1½
1	28-in. upright drill	2
1	24-in. upright drill	2
1	Sensitive drill	½
1	No. 2 Universal grinder	4½
1	Jones & Lamson lathe	2
1	15-in. lathe	1
2	16-in. lathes	2
1	14-in. lathe	1
2	19-in. lathes, total	3
1	24-in. shaper	2
1	22-in. planer	3
1	Cutter grinder	1
1	Twist drill grinder	1
19	Total	31

This motor equipment has carried the load quite satisfactorily, but certain changes have since made it necessary to replace the 10 horse power motor with a 15 horse power motor. The lineshafts are belted together so that if one motor is overloaded the other helps it out.

In the north bay are located the radial drills, planers, and the testing floor on which all shapers are run previous to shipment. Two lineshafts, each 90 feet long, are erected for the testing department, each lineshaft accommodating 12 shapers at a time. These lineshafts are driven from the main lineshaft by means of belts and friction pulleys so that either or both can be started and stopped at will without interfering with the main shaft. The testing lineshafts have two sets of pulleys for each shaper stand, so that both crank and geared shapers may be tested with one uniform speed of the lineshaft. Fig. 4 is a view of the testing department taken from the northeast corner of the bay.

The erecting floor or middle bay is 31 feet 4 inches wide. It is served by two hand traveling cranes, one of 2½ tons, and the other of 6 tons capacity. The sides of the monitor are

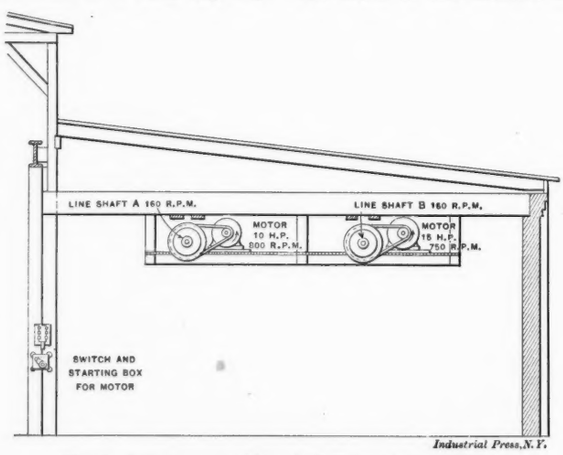

Fig. 5. Arrangement of Lineshaft Motors in South Bay.

almost solid glass, the window frames being set as closely as possible yet leaving space for the necessary supporting framework. The window frames are pivoted in the center and are connected to shafts operated by worms and wormwheels through vertical shafts from the floor so that the windows of any section may be readily opened for ventilation, etc.

Fig. 6 is a sectional elevation of the shop, looking toward the front. Fig. 7 shows the plan of the second floor of the office and a portion of the roof plan of the shop.

Shop Practice.

All shafts are ground to size on a Landis grinder, after having been roughed out in engine and turret lathes. All parts are jigged for drilling, boring and reaming with one important exception. This is the frame of the pillar shapers. For this work a special machine has been made which obviates the necessity for a jig. It consists of two Warner & Swasey boring machine heads, right- and left-hand patterns, mounted on a special frame connecting the two so that their spindles are dead in line. An elevating table with cross-feed makes a combination very similar to the Grand and Bogart double-spindle type of milling machine. A vertical and a horizontal scale gives means for measuring vertical and horizontal distances from certain datum lines, which are laid out on a special drawing for use in connection with this work. The operator sets the shaper frame to be bored so that it rests on the surfaces planed for the ram, which locate it vertically, and the location horizontally is determined from the face of the vertical slide. The location of the various holes is indicated on the special drawing, the distances being indicated from two datum lines which correspond with the zero marks on the scales when the casting is properly set. The holes are drilled and bored with end mills from the two sides simultaneously. The reaming is done from one side only as the reamers are run clear through both holes to insure their perfect alignment. This scheme seems to work satisfactorily in the matter of labor cost, and it must be fairly accurate since the shafts running in the holes bored in this manner carry gears meshing with fixed center distances. Even a slight variation under such circumstances will cause trouble.

A Putnam planer was noticed which has a feature not often found on planers, and that is two driving and two reversing belts, each having its own tight and loose pulleys. The object of this design, which was made to special order, is to give the driving power of a wide belt with the facility of shifting to be obtained only with a narrow belt. In this way a powerful drive can be obtained without the necessity of running at so high a belt speed as to cause disagreeable squeaking and slipping of belts at the reversals of the stroke. Another special feature of planer construction was noticed on another planer to enable the side heads to be used on both sides of shaper ram slides. With the side-heads extended sufficiently for such work, the overhang is so great that heavy cuts could not be taken. To support the slides a planed strip is bolted to the inside of each planer upright some distance back of the cross-rail. Two castings about three feet long with dove-tailed ends, are clamped in a horizontal position to the slides of the side-heads, with their opposite ends abutting against the strips bolted to the uprights. In this manner the thrust of the tools is transmitted to the uprights through the struts, thus relieving the side-heads of pratically all stress. Vertical movement, of course, is not interfered with since the ends of the struts abut against the vertical strips which offer no resistance to movement except in the direction of the thrust of the tools.

In the tool room special trucks are provided to transport the jigs and tools required on certain pieces, and each truck is reserved for that particular purpose. That is, instead of unloading a truck with all the attendant labor, whenever the jigs and tools are returned, it is left loaded until required

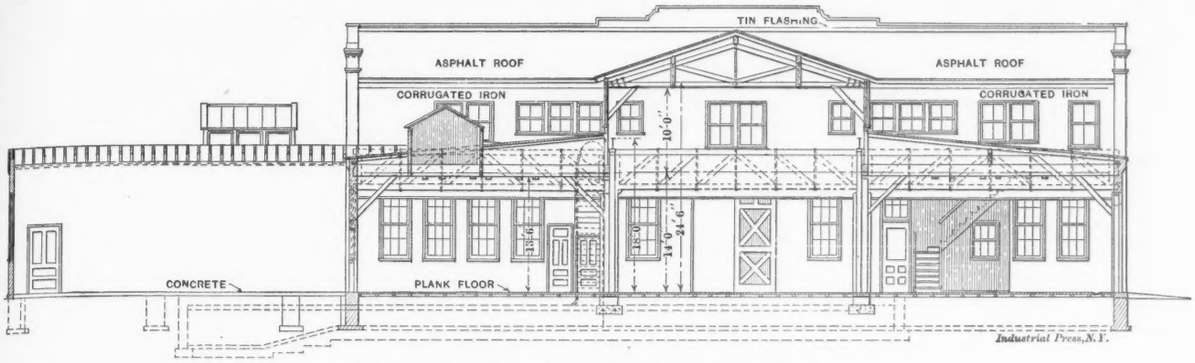

Fig. 6. Sectional Elevation of Shop, looking toward Front.

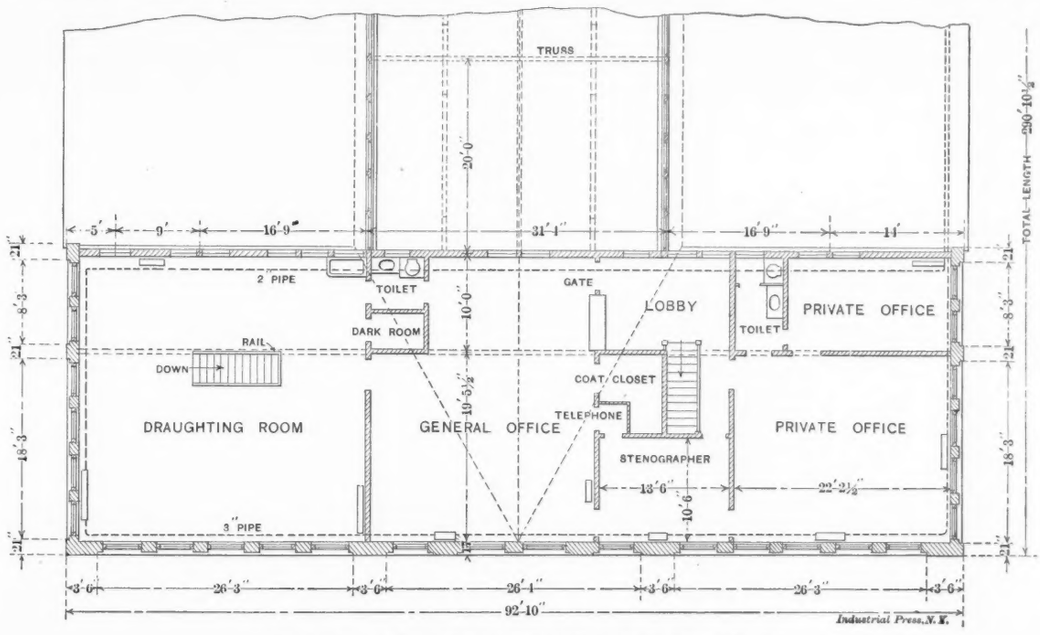

Fig. 7. Second Story Plan, showing Office and Portion of Roof.

for the next job and then all there is to do is to haul it to the drill-press where wanted. This plan would require considerable floor space in the tool room for the storage of all the trucks, but since a certain proportion are always out in the shop, this is not a serious objection. The convenience of handling jigs this way is apparent.

* * *

FIRST STEAM ENGINE IN AMERICA.

The first steam engine in America was imported in 1753 by Col. John Schuyler for use in pumping out his copper mine opposite Belleville, near Newark, N. J. This mine was rich in ore and was discovered by a curious chance. One of the Schuylers was plowing in a field when his negro slave found a large stone that was unusually heavy. His master saw that it contained copper and sent it to England for inspection, where it was pronounced 80 per cent. copper. Upon receiving the report Schuyler gave his negro his freedom and granted him three wishes. The old darky scratched his head and for the first wish chose to live with his master and have all the tobacco he could use; for his second wish, a dressing gown with brass buttons, like his master's; and for his third wish, more tobacco.

Col. Schuyler's mine had been worked as deep as hand and horse power could clear it of water. Its proprietor, having heard with what success steam engines, then called fire engines, were used in draining the mines of Cornwall, determined to have one in his own mine. He accordingly requested his London correspondent to procure an engine and to send out with it an engineer capable of putting it up and running it. A Hornblower engine was, accordingly, ordered, and Joseph Hornblower, one of the sons of the builder, became interested in the machine and came over to erect and operate it, expecting to return later. The voyage was a long and perilous one, and Mr. Hornblower's services proved so satisfactory that the proprietor induced him to remain—all the more willingly, probably, because the American girl had proved as attractive to him as she has to many other men from foreign lands, the girl in this instance being a Miss Kingsland, whom he married.

Josiah Hornblower's father, whose name was Joseph, had been engaged in the business of constructing steam engines in Cornwall from their first introduction in the mines there, about 1740; and had been an engineer and engine builder from the first use of steam engines in the arts, about 1720. The engines constructed by him and his sons were Newcomen engines, or Cornish engines, using steam at atmospheric pressure. There was an immense wooden walking beam, with a segment at each end from which hung chains; the chain from one end attaching to the pump rod and from the other end to the piston rod. The pump rod descended by its own weight and was pulled up again by the air pressure on top of the piston, the steam having been condensed under the piston by a spray of water, producing a partial vacuum.

At the time Hornblower's engines were built, Watt had not invented his separate condenser, nor discovered the use of high-pressure steam. After 1760 the Schuyler mine was worked for several years by Mr. Hornblower himself.

* * *

EXAMPLES OF INERTIA.

We are all familiar with many experiments to demonstrate the inertia of matter, sometimes called the passiveness of matter—its dislike to get into motion when at rest and its desire to keep moving when once in motion. One of these is the old trick of firing a candle through a door panel. The candle travels so rapidly that when it strikes the door its particles do not have time to slide one upon another, and the soft candle flatten out, as would be expected; but instead it will crash through the wooden door, if we are to believe our text books. Whether it actually would do this or not can only be told by those who have performed the experiment, which would seem to be rather a dangerous one, owing to the possibility of bursting the gun. It is known, moreover, that a person hunting in the winter-time should be careful not to run the muzzle of his gun into the snow, lest the end of the bore become filled with snow and the gun burst when fired. While the snow would be almost infinitesimal in weight, it would have to start instantly into motion, at the rate of perhaps a third of a mile a second, when the powder ignited. While it may be hard to realize it, more force would probably be required to accomplish this result than the strength of the gun barrel could stand and the barrel would rupture under the strain.

Examples like the foregoing are very familiar, but some other tests quite as instructive, but more out of the ordinary, have recently been explained before the Royal Society of London. The tests were first made with a copper sphere about 5 inches in diameter, in the center of which was a glass flask about 1 to 1½ inches diameter, retained in position by cotton packing. The sphere was perforated to allow water to enter its interior and then it was sunk in the ocean on the end of a sounding cord to a great depth. The pressure of the water increased, of course, as the sphere descended, until it became so great as to burst the glass flask, which was filled only with air. This gave a momentary relief to the high pressure within the sphere, and its copper walls collapsed. The inertia of the water was so great that it could not be set in motion quickly enough to fill the space occupied by the glass flask before the collapse of the outer sphere. Another similar test was made with a copper tube, open at the ends, and containing a small glass vial. When sunk sufficiently deep the vial crushed, relieved the pressure within the tube and the latter collapsed, before the water had time to run into the ends of the tube for the support of the metal walls. These tests are all the more striking when it is remembered that the water was under such high pressure at the depth of the sphere or tube, that it must have flowed at an extremely high velocity into the sphere or the ends of the tubes; but yet it was too late to prevent the action cited.

* * *

RAPID COAL HANDLING.

In the last number we published a brief item in regard to the coal handling machinery installed by the C. W. Hunt Company at the Lincoln Wharf Power Station of the Boston Elevated road, which marks a decided advance in the speed with which coal has heretofore been hoisted from barges, cracked to uniform size and delivered to storage pockets. The installation consists of two hoisting towers with the moving gear and coal cracker electrically driven and the hoisting engine direct-connected. The towers have to traverse overhead the whole length of the coal storage pocket and to move 30 feet at a time without changing steam connection. The boom of each tower has an overhang of 40 feet. With one of these towers run-of-mine bituminous coal was raised 90 feet above the tide water from one hatch of a vessel and delivered to the storage pockets, cracked to a mechanical-stoking size, at the rate of 320 tons per hour, by one tower.

To attain this end, the steam engines of fifty to one hundred combined horse power in common use have been replaced by machinery of three hundred horse power, and the coal-cracking machine attached to the tower cracks to the proper dimensions for automatic stokers, before passing to the pocket the enormous quantity of coal over five tons per minute, delivered to it from the hoisting machinery. The ordinary small steam shovel has been supplanted by an automatic one of two tons capacity at each lift.

The time occupied in raising two tons of coal from the hold of a vessel to the discharging hopper, nearly one hundred feet above, is only six seconds, while the round trip, involving the operations of lowering and moving the shovel out of the boom, opening the former, digging up two tons of coal, raising it to the level of the hopper and discharging it therein, is frequently performed in twenty-two seconds.

The work demanded of coal hoisting towers and their machinery is of the hardest description, both from the unskilled nature of the labor employed, and the shocks to the machinery incidental to the service; and it changes constantly with the nature and size of the coal, which may vary from a soft pea variety contained in open wooden barges, to a hard foreign product in cubes, two feet square, loaded in steel vessels with small hatches.

FOUNDRY AND PATTERN DEPARTMENTS OF THE B. F. STURTEVANT COMPANY.

In November of last year we published an outline of the preliminary plans for the new works of the B. F. Sturtevant Company, at Hyde Park, Mass. Since that time the plant has been nearly completed and occupied and we give herewith a general description of the pattern and foundry departments. The new works were commenced shortly after the destruction of the greater portion of the old works at Jamaica Plain, Mass., by a disastrous fire, and afford over double the space of the latter, an increase in facilities that was much needed by the rapidly growing business of the firm. The new plant comprises a commodious office building; a building devoted to the manufacture of blowers, heaters and galvanized iron work; a building for the electrical department, and for testing steam engines; a general machine shop, used mainly for engine building; a forge shop; foundry; pattern building, and power house.

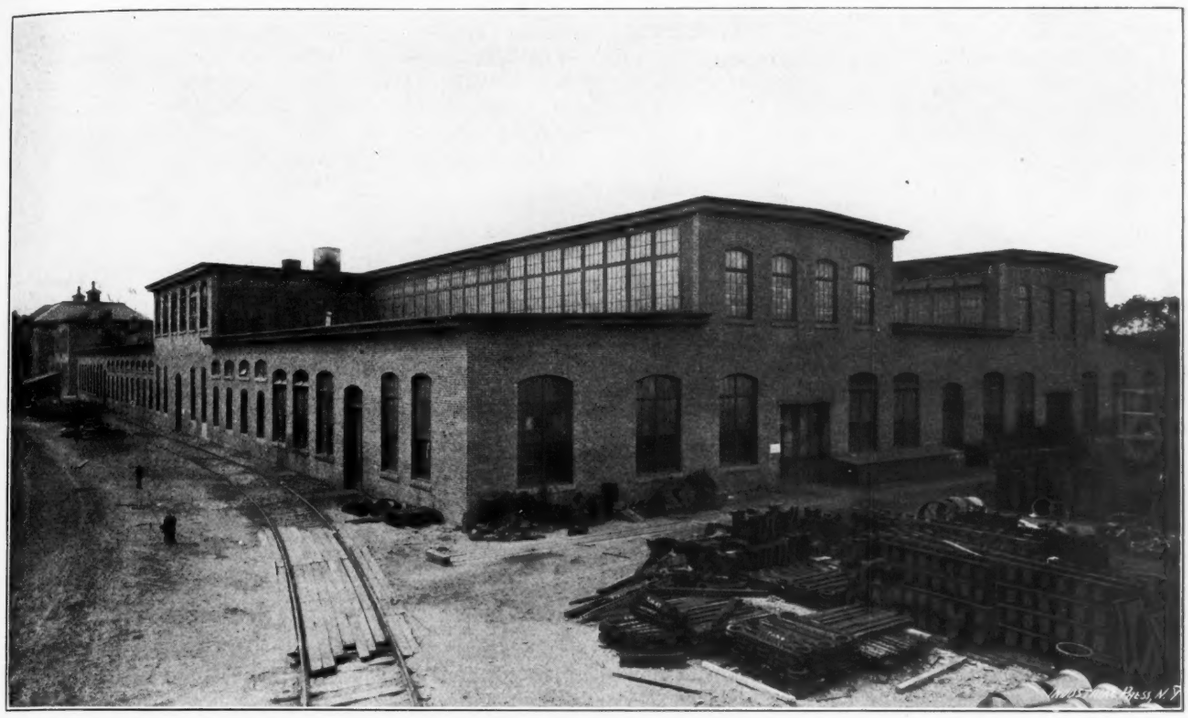

Fig. 1. New Foundry of the B. F. Sturtevant Company.

Fig. 2. Interior View of Foundry, showing one of the two Main Craneways and the Low Brick Walls dividing the Foundry into Sections.

The arrangement of the buildings has been given careful study, resulting in a simple lay-out of the inter-transportation facilities, and the convenient handling of incoming and outgoing freight. The foundry and pattern departments,

which form the subject of this description were the first to be put in operation prior to the removal of the entire plant from Jamaica Plain.

The Pattern Building.

The pattern building is divided midway of its length by fire walls enclosing stairs, elevators, etc. One-half the building, with stories respectively 17 and 15 feet, is devoted to the flask and patternmaking rooms, while the other half, provided with intermediate floors, making four in all, is utilized for pattern storage. The spacing of the floors will be evident from the exterior view in Fig. 7.

The industrial railway runs directly into the flask shop from the foundry and together with an overhead transfer track reduces to a minimum the cost of handling flasks. The lumber is unloaded from cars directly in front of the building. This room also includes the metal patternmakers' department.

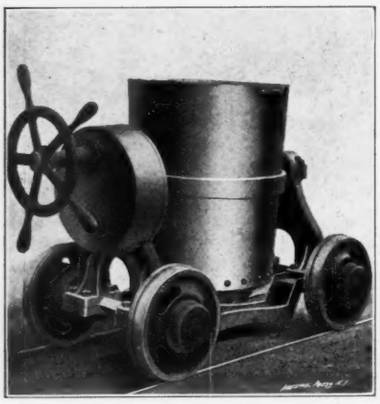

Fig. 3. One-ton Spur Gear Ladle Truck.

Fig. 4. Transfer Truck for Crane Ladle.

Fig. 5. Dump Car.

Immediately above the flask shop is the pattern shop, abundantly lighted upon three sides and equipped with a full complement of tools. The benches accommodate two men each and measure 2 feet 6 inches in width by 16 feet in length. They are so arranged along the sides of the building that the men all receive a left-shoulder light. Behind each bench is a working table 4 feet by 16 feet in dimensions. The benches are supported upon cast iron legs of special design which were built by the Sturtevant Company and are used throughout the plant. They are equipped with Emmert vises and their tops are of heavy maple plank. A warming chamber for glued work is provided which receives warm air through the heat flue. Sturtevant motors are employed in this building, in 10 horse power units, which provides for a relay in case of a breakdown.

Fig. 6. Turntable for Industrial Railway, with Cover Lifted.

Around the pipe columns which support the floors of the pattern storage end of the building are clamped the pattern shelving brackets which are adjustable to any height. All patterns are consecutively numbered upon the drawings as made. When delivered to the pattern storage department proper locations are assigned, and records thereof made upon cards, one for each pattern. These cards are filed in the order of the pattern numbers. Four figures with the addition of a letter are in every case sufficient to locate a pattern. A given location, for instance, may be 2125B; that is, it is upon the second floor, as shown by the first numeral, "2"; it is in the twelfth row of shelves and the third division of that row, as shown by the succeeding numerals "125," and on the B level, the floor being designated A, and the letters B, C, D, etc., indicating the shelves in their order above.

The first floor is of concrete and is designed for the keeping of heavy cast iron patterns. It is served by an industrial railway and turntable which permits of transfer to the elevator and thence to other floors. Communication between the pattern shop and storage department is direct, while the fire risk is reduced to a minimum by a double system of fire doors.

The molder's written order to make a specified number of castings is issued by the foundry office, directly to the pattern keeper, who makes record thereon of the pattern location, attaches it to the pattern and sends both to the foundry. A metal clip placed upon the storage record card indicates that the pattern is out.

The Foundry.

The foundry consists essentially of two long craneways, each 35 feet in width, with center bent of the same width and side floors 30 feet wide. The brass foundry, core room and wash room are located at one end; the charging floor at one side, nearly midway of the length, and the cleaning room at the other end. The craneways are designed for 20-ton electric traveling cranes. Those already installed are of the Whiting Foundry Equipment Company's make and are equipped with Sturtevant motors.

A feature of the foundry arrangement is the location of two division walls 3½ feet high, so as to separate the floor into three divisions on the lines of the columns. Breaks in these walls occur at intervals, allowing passage from one division to another. The walls serve the purpose of dividing the foundry into different sections for different classes of work, without actually making several separate rooms or buildings, and also serve as extra wall space against which flasks or tools can be leaned.

In the center line of each of the craneways and in the bent between them runs an industrial railway with turntables connecting with the cross aisles which provides for the distribution of metal, etc., to all parts of the building. The floor between the craneways is supplied with a series of 1½-ton small traveling cranes of about 10-foot span equipped with Sturtevant electric hoists built especially for this work.

All materials are received from a track which runs along one side of the foundry and are delivered through wall openings to the bins which fill a portion of the side wing adjacent to the cupolas. These various features appear in the three interior views of the foundry herewith.

Lighting is secured through side windows and monitors. Each line of monitor transoms is operated in unison by a novel device installed by the G. Drouve Company. The western side of the foundry is given up to bench and small floor molding, the bench molders' floors being separated at the

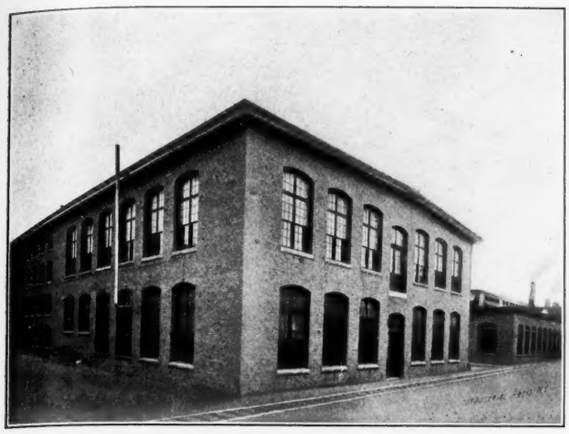

Fig. 7. Woodworking and Pattern Storage Building.

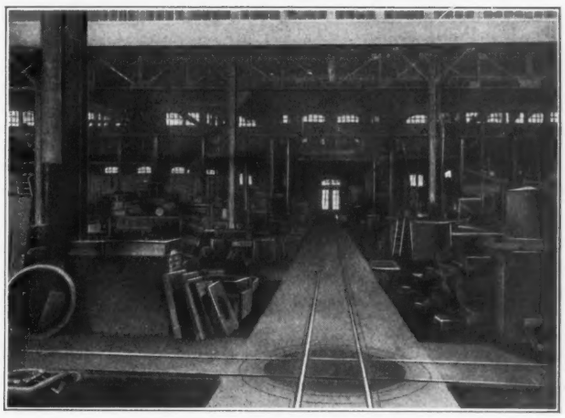

Fig. 8. Looking Across the Foundry.

Fig. 9. Interior, showing one of the Side Bents of Foundry.

Fig. 10. Pickle Room.

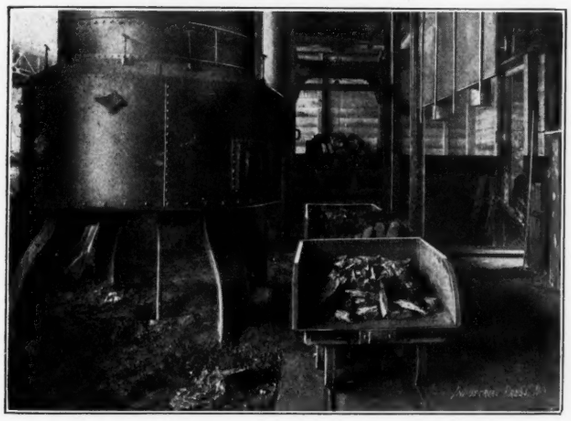

Fig. 11. Charging Car, Ground Floor at Cupola.

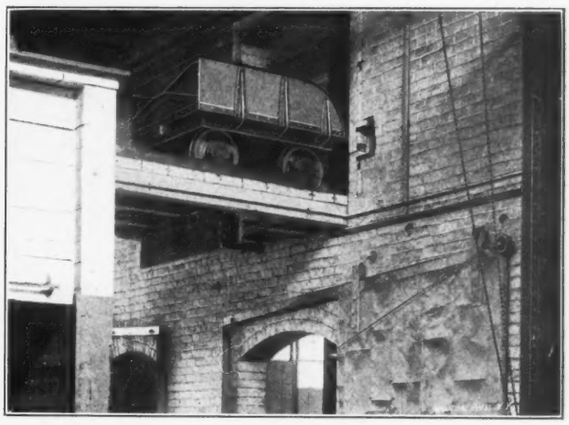

Fig. 12. Car Entering Drop Elevator.

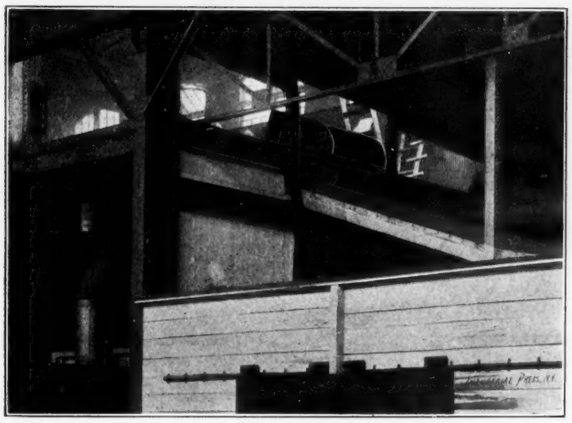

Fig. 13. Car Entering Chute.

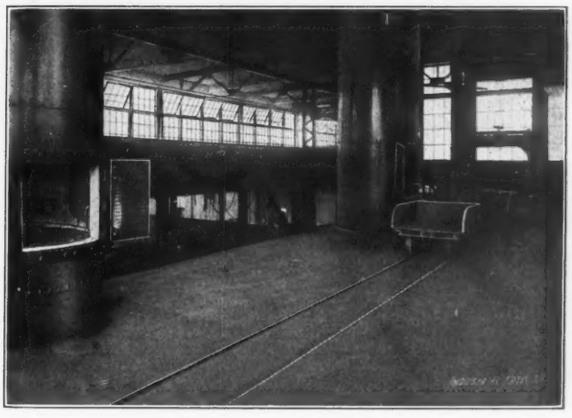

Fig. 14. Cars on Charging Floor.

VIEWS OF THE NEW B. F. STURTEVANT FOUNDRY AND PATTERN BUILDING.

bench ends by wooden partitions. The floors throughout this side of the building as well as those in the storage bins and center runways are of concrete. Alongside the industrial railway, which serves iron from ladle trucks to the bench floors, is a sunken trench laid with common brick as a suitable place for drippings and for the piling of hot castings.

The Cupola Arrangement.

An ingenious system of charging has been devised under which the charging cars pass at floor level in front of the bins, are there loaded with the requisite amounts, weighed, and passed to the elevator where they are raised to the charging floor. As each car is unloaded it is pushed forward and started down an incline whence it passes back in a direction opposite to that traversed while being loaded on the floor beneath. A novel apparatus gradually brings it to a standstill while yet upon the incline, and then releases it so that it may, by its own weight, roll onto an elevator which is automatically tripped and descends to the ground floor level. Here it is removed by one of the loading men and the elevator returned to its place above, ready to receive another load. A number of views are shown of the charging car in several positions.

The cupolas are two in number, of Whiting make, 54 and 72 inches in diameter, and the blast is secured by Sturtevant pressure blowers; a No. 8 and a No. 10 blower are driven respectively by a 30 and a 40 horse power belted motor, being supported upon the charging platform through which they discharge directly downward and thence to the cupolas. It is intended to make this installation the subject of critical experiment for the establishment of important principles.

The entire transportation equipment of the plant, including tracks, cars, trucks, etc., was designed and built by the Sturtevant Company. The tracks in the foundry are imbedded in the concrete runways and all changes of direction are secured by turntables, there being no switches in the works, and therefore no radial truck cars, all cars having rigid bases. The turntables are designed very heavy to avoid distortion or breakage and consist of a bottom frame with four roller wheels, Fig. 6, which are carried upon composition trunnions, and a cover, which is recessed for crossing tracks at right angles, and is provided on the underside with a chilled tread, with which the wheels come in contact. A small idler wheel is provided which automatically stops the turntable on each quarter, but readily releases it. The cover is accurately centered by a chilled conical bearing.

The cars are provided with a special type of ball bearing, practically devoid of machine work, but with chilled wearing surfaces. The ordinary flat cars, as well as the charging cars, are built up of structural steel. The geared ladle cars have malleable iron frames and enclosed spur gear mechanism. Similar construction is employed in the case of the transfer cars for geared crane ladles of medium size, while a simple low platform truck is utilized in the case of the largest crane ladles. The dump cars are in the form of inverted cones and so balanced as to be tipped with the utmost ease. The taper of the cone is such that these cars are practically self-dumping.

Brass Foundry.

The brass foundry, located at one corner of the main building, is provided with four crucible furnaces and a special form of reverberatory furnace designed principally for the melting of babbitt or similar soft metals. An overhead traveler with interlocking transfers on the side floors serves the entire area of the room.

In the middle of the end of the foundry is the core room. The ovens are six in number, three being 7 feet in diameter, of the reel type and three being respectively 4, 5 and 7 feet in width by 8 feet 10 inches in length, provided with cars. An overhead traveling crane serves these latter ovens and provides for the transfer of heavy cores to the industrial railway which passes through this room. A portion of the room is partitioned off and serves for the women core makers employed in this department. The floor is of concrete. The tops of the ovens are utilized for storage of cores upon a special rack of steel construction.

At the other end of the foundry is the cleaning room, through which run the longitudinal tracks from each main aisle of the foundry. A five-ton three-motor electric crane of the Whiting Foundry Equipment Company's manufacture equipped with Sturtevant motors serves the principal portion of the floor in this room. The tumbling barrels, six in number, are completely enclosed in housings of steel construction. These, together with a Sly cinder mill and several emery wheels are driven by a 30 horse power Sturtevant motion. A temporary air compressor, located in one corner, supplies air at 100 pounds pressure to chippers, stokers, hoists, etc., employed in connection with this work. The light and ventilation of this room are noticeably good.

Adjacent to the cleaning room is the pickle room, Fig. 10. The floors of both are of concrete. The pickle beds are of teeter board construction so designed that the acid may be drained back into the vats and the board subsequently teetered over for washing into the trench upon the other side of the room. The floor slopes for drainage. A pneumatic traveling crane serves this room.

One of the notable features of the equipment of this plant is to be found in the sanitary arrangements. Most generous provision has been made in the case of the foundry, which has a large locker and wash room. Expanded metal lockers to the number of 225 are already in position. Enameled iron sinks, six in number, are served with tempered water and are generously patronized by the employees. A series of slate partitioned shower baths has proved to be very acceptable during the past summer. The floor of this room is of tar concrete; the upper walls and ceilings which are white and fresh are in pleasing contrast with the steel work and base of the walls which are finished in rich dark green. Within the same room is installed the time-recording system, so placed that a double line of men pass, one upon either side of the board, as they go and come from the room. The foundry foreman has not been forgotten in the matter of convenience, and he with his assistants is provided with an attractive office, well lighted and susceptible of thorough ventilation from out of doors.

The entire plant is heated and ventilated by the Sturtevant system. In the case of the pattern building, the apparatus consisting of an engine-driven fan and steel pipe heater is placed close to the division wall and delivers the heated air into a vertical flue and thence to the various rooms. The foundry apparatus is located overhead in the end of one of the craneways and arranged to take fresh air from out of doors or return from the building and reheat it. Distribution of air is made through a system of overhead galvanized iron piping, discharging downward to the floor. Both apparatus utilize exhaust steam. A complete underground tunnel system is provided for distribution of steam, electricity, compressed air, etc., and return of condensation.

* * *

What is said to be the most dangerous railway in the world is that recently completed up the side of Mt. Vesuvius for the benefit of the many tourists that annually visit this famous volcano. It is a cable railway of the mono-rail type, the one car comprising the active rolling stock being supported by two wheels, one at each end of the car. The center of gravity of the car is below the top of the supporting rail so that it balances without the aid of supporting wheels at the sides. The railway line runs to within nominally 1,000 feet of the crater mouth, but the distance changes from day to day on account of the rapid changes that take place; accretions to the sides of the crater may materially increase the distance one day, and the fall of a huge slice into the seething gulf 500 feet below, may considerably lessen the distance the next day. The maintenance of the line in proper alignment is a difficult matter. Fissures opening, the flow of lava, falling cinders, and sliding of the roadbed require constant watchfulness and labor by gangs of laborers who constantly patrol it during the periods of operation. The "train" has no fixed time-table, the trips depending on the activity of the volcano and direction of the wind; some days they are entirely abandoned.

ALTERNATING CURRENT RAILWAY MOTOR.

United States Consul-General Mason, Berlin, Germany, has been more active in collecting and sending information to this country upon technical and engineering subjects than any of our foreign representatives. In a recent consular report he devotes considerable space to a general description of a new variable speed motor for electric cars operating with a single-phase alternating current of 6,000 volts, without conversion to a lower voltage or to direct current. A car equipped with one of these motors has been in operation on a Berlin suburban line and it is stated that its speed can be varied to any desired degree without cumbersome or expensive regulating devices. The motor was invented by a young Austrian electrician and built from his plans by the Union Electric Company, Berlin. If the motor should prove on extended trial to accomplish all claimed for it, it is an invention of great importance, for it apparently accomplishes a result not heretofore attained. Readers may possibly remember the description of the Arnold system of electric traction in the technical press about a year ago, in which system alternating current motors are employed. But Mr. Arnold found it necessary to provide a compressed-air storage reservoir and an air engine, connected with the electric motor and also the car axle by suitable mechanism, in order to obtain the full variation in speed desired. Various other systems, more or less complicated, have been worked out to avoid direct-current motors on electric cars and the consequent converter and transformer stations along the line of the road, in installations where alternating current is used for the transmission.

No information is at hand regarding details of the new Austrian motor, but Consul-General Mason's description and very intelligent comments are of interest. He says that alternating currents of high pressure, which are taken off at intervals by substations, as mentioned above, work very well for short suburban and city lines. But when the proposition is to extend the same practice to a standard railway, connecting two cities from 100 to 300 miles apart, the cost of the installation and working expenses become practically prohibitive. Besides the frequent substations equipped with converters and transformers capable of changing the high-voltage alternating current into a low-pressure continuous one, there is the question of heavy copper conductors throughout the line, and this, added to the fact that the transformers and rotary converters must stand idle except when the converted current is taken off and used by some passing train, has hitherto rendered the proposition economically untenable.

When the high-speed experiments were tried last year on the government railway line between Marienfelde and Zossen, an alternating three-phase current of 10,000 to 12 000 volts was carried along the line on three copper wires and conducted thence by trolleys to transformers carried under the floor of the car, whence it was transformed to 1,150 to 1,800 volts and passed into the three-phase induction motors. The car easily attained a speed of 140 to 150 kilometers an hour, at which pace the rails began to give way. The experiments had to be postponed until a more solid and substantial track could be provided, but have recently been conducted successfully.

The present experiment has therefore a wholly different purpose. It involves no question of extreme high speed, but rather the transmission of a single-phase alternating current at a voltage sufficient to carry it over a long line on a small and relatively inexpensive wire, and the direct use of the current, without transformation, by a motor capable of running economically at any desirable speed and which fulfills all the other requirements of electric traction. The point demonstrated by the tests now in progress is the effectiveness of the new motor for the special purpose to which it is applied. No sparking or other technical difficulty appears thus far to shadow the success of the experiments. The system eliminates the expensive substations, with their heavy initial outlay and operating expenses, and is so simple and direct in its working that it may, at least in theory, be applied to lines several hundred miles in length. If the distances are very great, of course the power may be transmitted from a distant waterfall or steam plant at any desired pressure—say, 20,000 or 50,000 volts—and then reduced in ordinary transformers, requiring no especial care, to the working-line voltage of, say, 6,000 or more. The present tests are over a line of 3 or 4 miles in extent, the length being immaterial. There may be encountered new technical difficulties when this distance is increased to as many hundred miles, but such difficulties are only such as may be met in any long-distance transmission and such as electrical science at its present stage is fully prepared to overcome.

* * *

OF HISTORICAL INTEREST.

In a brief paper read before the Engineers' Society of Western Pennsylvania on early experiences in transportation, Mr. Antes Snyder referred to the regulations promulgated for the control of traffic on the State railways of Pennsylvania. When the commonwealth opened the Philadelphia and Columbia Railway, the theory was that the State furnish the roadway, and that any one who pleased could furnish his own vehicle and motive power and use the railway whenever he wished, by paying the State tolls for its use, just as the turnpikes of the day were used. But it was soon discovered that a certain character of vehicle was necessary and that rules and regulations as to times and manner of using the railways were absolutely necessary to effect their successful operation. The ordinary shippers found it too expensive to fit themselves with the necessary plant, and that they could get this transportation done by large and well-equipped shippers much more cheaply than they could do it themselves, so that in practice the business drifted into the hands of a few individuals and companies, who did this service for the many. The railway as constructed was intended for the horse as motive power, though the locomotive was being introduced as an experiment shortly after the railway was completed. The following, among the rules and regulations adopted by the Canal Commission for the regulation of the railway, may be of interest:

"Section 92.—No car shall carry a greater load than three tons on the Columbia and Philadelphia Railway, nor more than three and one-half tons on the Portage Railway, nor shall any burden car travel at a greater speed than five miles per hour, unless the car body and load shall be supported on good steel springs.

"Section 108.—It shall be the duty of the conductors of cars moving with less speed upon the railways, upon notice by ringing a bell, blowing a horn, or otherwise, of the approach of a locomotive engine or other cars moving in the same direction at a greater speed, to proceed with all possible dispatch to the first switch in the course of their passage and pass off said track until said locomotive engine or other cars moving at greater speed can pass by. The conductors of the slower cars are directed to open and close the switches so as to leave them in proper order. Any person who shall refuse or neglect to comply with the provisions of this regulation shall, for every offense, forfeit and pay the sum of ten dollars."

It must have been a very interesting and novel sight, indeed, when the horse and the locomotive were used indiscriminately on the same track and were struggling for supremacy as the future motive power of our railroads, and the approacn of a locomotive was heralded by the tooting of a horn. Even at that time the right of way was given to the fast horse.

* * *

What is said to be the largest and most powerful towboat ever built for the Mississippi River was recently constructed at Dubuque, Iowa, to the order of the Monongahela River Consolidated Coal and Coke Company, Pittsburg, for use in taking down river the immense fleets of coal barges. She is the usual stern-wheel type of steamer which predominates on the Western rivers, but in size is very much larger than any boats yet built, her "over all" length being 318 feet. The hull is built of steel from the boiler deck down, the general dimensions being as follows: Length of deck, 277 feet; beam, 61 feet; depth, 7 feet. To give sufficient strength to this long and very shallow vessel 3 fore-and-aft bulkheads are fitted, and a system of chains and braces, similar to the hog frame in side-wheel steamers, is built to take up the strains due to the heavy weights resulting from placing the boilers forward and the engines aft.

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The growth of the oil industry in the United States has developed a highly skilled class of operators known as drillers, who are able to rapidly and cheaply sink bore-holes into the earth to depths of 1 000 to 2,000 feet, and more. But in these operations it is rare that a bit as large as 12 inches is used; the usual size being under 8 inches diameter. What then would the average driller think of sinking a shaft 9 feet diameter by the jump-drill operation? It would certainly be regarded as a big contract by most of them. At the present time, however, a colliery shaft is being sunk at Dover, England, by the Kind-Chaudron system which uses a special cutting tool called a "trepan" attached to a very heavy walking-beam by pitch-pine rods. The trepan is 9 feet across the cutting edge, which consists of 19 steel bits in line, each weighing over 100 pounds. This process has been used in Continental countries for some years in sinking mine shafts through ground in which extensive water strata is met with, but beneath which an impervious stratum will be encountered. When this strata has been reached by the "trepanning" operation the shaft is lined or "tubbed" with heavy iron rings tightly packed at the lower end by a "moss-box" to exclude the water.

* * *

The three-cornered muddle over the contracts to be let for the new battleships, in which the Bethlehem, Carnegie, and Midvale Steel companies are participating, promises to introduce a new point in law that is of considerable interest to manufacturers. The Bethlehem and Carnegie companies both have large and complete plants for producing armor plate by the Krupp process, and these two companies claim to control the rights for the use of this process in the United States, and exact a royalty from the government on the plate made at government plants. The Midvale company have not yet completed their plant for the manufacture of armor plate, and it is not known what process they intend to use; but it is surmised that it will be the Krupp process, also. The Bethlehem and Carnegie companies not only claim that the Midvale company will not be able to complete its contract, if it secures it, within the time specified, but further assert that they will compel the government to pay royalties on all the plate furnished by the Midvale company, inasmuch as it will infringe on the rights to the Krupp process, which the former concerns control. The peculiar part of the situation is, however, that there is no patent on the Krupp process, and that propriety rights with regard to it are held solely in virtue of its being a secret process and one that has been developed at great cost and has required the establishment of immense plants for its production. Will the courts decide that there is property in a secret process, even after it has been discovered by other persons and put to use by them? Apparently there is a new point of law involved which it has heretofore been supposed did not exist—and probably would not exist except for the millions of vested interests involved in the equipment of the plants. It remains for the courts to say, however, that this makes the tenure of the process itself any the more secure.

* * *

ONE WAY TO KEEP UP THE DEMAND.

Not long ago a prominent manufacturer and inventor of special machinery was relating his experiences and cited a certain product which he had developed some 20 years ago and was ready to put on the market. The product was for machine shop use, and inasmuch as the publication of its name would at once indicate at least one of the principals in the incident to be mentioned, it will answer our purpose to call this particular product a new brand of hack-saw blades, which, however, it was not.

The blades which this gentleman produced had remarkable qualities, particularly in the matter of durability. This was obtained in part by using a superior quality of steel, but mainly by the method of manufacture, which involved a forging process, by means of a special machine built for the purpose. The process gave to the steel a peculiar density and toughness previous to its being converted into saw blades, and it was found upon repeated tests that a blade produced by this means would outwear any four blades as usually made. The invention also included methods for nicking the teeth and finishing the blades, which reduced the cost of production to such an extent that blades could be manufactured by the new method at considerably less cost than any other blades had ever been produced for.

Now, Jones & Co. were the largest manufacturers of hack-saw blades in the country; so large, in fact, that they practically supplied the trade and had all they could do to keep up with their orders. They in some way heard of the work of the inventor and made overtures for the purchase of the invention. The inventor stipulated that if it were disposed of, the sale must be effected without the purchaser seeing the machine, or any of the apparatus; that cash must be paid; and that on his part he would guarantee the method to be all he claimed for it and the machine to be well constructed and free from trappy features. He furthermore agreed that in case the machine would not do what was claimed for it, he would refund the money, the question of refunding to be decided by a committee selected from the employees of Jones & Co., the prospective purchasers. Although these conditions were very unusual, the invention was apparently so valuable that the price of $25,000 was paid outright, and there never was a question raised as to the refunding of the money.

This sale, however, was the end of the invention, and it never after saw the light of day. Jones & Co. believed that if saw blades were put on the market which would outwear four times as many blades of their own manufacture, there would then not be as many people to buy saw blades, and that their production would be cut down to so great an extent as to be ruinous to their business. Although the new blades could be made cheaper and sold for a lower figure, or at the same figure at a greater profit, they still thought it to their interest to shelve the invention and so compel people to use blades of inferior quality and buy more of them.

There have been many firms who have held to the same mistaken and ancient views as Jones & Co., but fortunate it is that they have not been in the majority . It was perfectly natural that this company should have desired to control the best processes for making hack-saw blades, and should have purchased the invention of our friend; but if they had also made an effort to produce the best article that could be made, and had put it on the market at a fair price, they would have been more in line with present-day practice, for the best foundation for any business is the reputation for the best goods at a fair price.

Dr. Th. Goldschmidt, the well-known German chemist and discoverer of thermit, will give a lecture on this compound and make a demonstration of the thermit welding process at Columbia University some time during the second week in November. Further information may be obtained from Mr. Ernest Stutz at the Murray Hill Hotel, New York.

Gordon McKay, the millionaire inventor of shoe machinery, died on October 19. McKay was born in Pittsfield, Mass., and when a small boy showed a talent for mechanics. His first employment was with the Lowell (Mass.) Machine Company, where he helped in building the first locomotives for the Boston & Maine Railroad. Early in his life he became associated with L. R. Blake, of Arbington, Mass., who invented a shoe-sewing machine, which eventually proved a failure. McKay saw its possibilities, however, and bought the patent rights. Then he inserted the necessary improvements and began to make his millions. He later invented a heeler, lasting machine, and shoe-nailing machine, and through the use of these was the only manufacturer in a position to offer to make shoes for the Union Army. The fortune that he amassed can only be estimated. At one time he was receiving a commission of from ½ to 4 cents on every shoe manufactured with the aid of his inventions, from Maine to California, in addition to enormous royalties from his British patents. Harvard University will now receive $4,000,000 of McKay's fortune, which was placed in a trust fund for the university in 1893, but at the time of his death it was not known to whom the balance, and probably the greater part of his fortune, would go.

THE DATA SHEET FOR THE CURRENT ISSUE.

The tables comprising the data sheet for this month have been furnished us by the Garry Iron and Steel Co., Cleveland, Ohio, and represent the practice followed in their engineering department for the design of round shafting. They consist of diagrams by means of which may be solved graphically the formulas for round shafts when subjected to twisting moments, bending moments, or to a combination of both twisting and bending moments.

Table 1 is calculated on the formula $T = \frac{Sd^3}{5.1,}$ and consequently for a given twisting moment, T, the diameter of the shaft $d = \sqrt[3]{\frac{5.1\,T}{S}}$. In this formula S represents the fiber strain per square inch and the diagram is arranged for values of S from 4,000 to 24,000 pounds per square inch.

Table 2 is arranged to give the diameter of shafts subjected to bending moments. The formula for shafts loaded in this manner is $M = \frac{S\,d^3}{10.2}$ giving a value for the diameter $d = \sqrt[3]{\frac{10.2\,M}{S}}$. In the diagram seven values of S are given, ranging from 5,000 to 30,000 pounds per square inch.

Table 3 is used for determining the size of shafts that are subjected to a combined twisting and bending moment. Upon the horizontal base are denoted the twisting moments and upon the vertical side the bending moments. By following vertically and horizontally the respective lines representing the given moments, their point of intersection will fall upon a line which represents the diameter of a shaft of suitable size to sustain the combined load. This diagram is calculated by the well-known formula:

$$\text{Combined moment} = M + \sqrt{M^2 + T^2}$$

in which M = bending moment,
T = twisting moment.

The results of this diagram are based on a tensile strength of 7,500, and a shearing strength of 6,000 pounds per square inch. If we desire to find the diameter for any other tensile strength we first find it from Fig. 3 and then, by referring to Fig. 4, find a new diameter for any desired fiber strain from 5,000 to 30,000 pounds per square inch.

DESIGN OF PUNCH AND RIVETER FRAMES.

JOHN S. MYERS.

In the design of a punch, riveter or shear frame the depth of throat or gap G, and the height of the throat H and h, Fig. 1, are determined by the size and character of the work to be done. In riveters the stake is usually fixed by the smallest shell that is to be riveted, and dimension O must consequently be less than the internal diameter of this shell. It is customary, when thus limited, to make the section of the stake as shown in Fig. 2 in order to obtain as deep a section as possible. The strength of similar sections varies as the cube of the depth while the area varies as the square of the depth, so that ordinarily, a deep section is more economic of material than a shallow one. If, however, the depth D

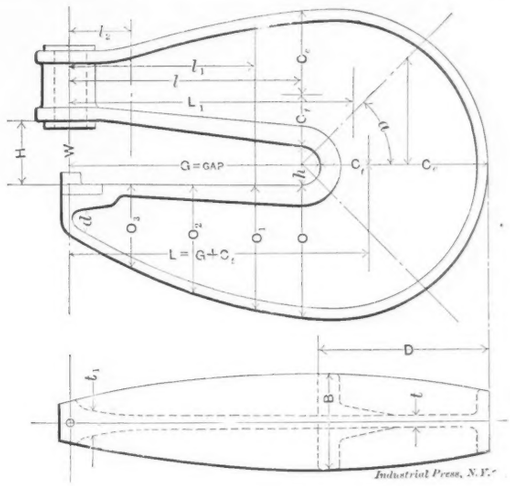


Fig. 1

is great in proportion to the gap G, as shown in Fig. 3, the length of the compression flange is increased to such an extent that the entire frame is heavier than it would be if a shallower section were used. A machine of one hundred and eighty tons capacity, having a gap G of 9¼ inches was found, when made of steel castings, to be considerably lighter with a depth D of 16½ inches than when this depth was made 22 inches.

In riveters of long gap the spring or deflection is an important factor. This varies as the cube of the length and inversely as the moment of inertia of the section. For similar sections the moment of inertia varies as the fourth power of the depth; hence the adaptability in riveters of deep gap of the form of section shown in Fig. 2, keeping the depth of section as great as is consistent with the work to be done.

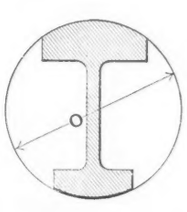


Fig. 2.

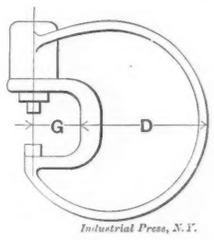


Fig. 3.

In designing punches and shears, the dimensions O, D, B and t are selected according to the judgment of the designer. The frames are usually made of cast-iron as a more rigid frame can thus be produced for less money than if it were made of steel. If it is portable, however, weight becomes the main factor and steel may then be used advantageously. The thickness of the web t is mostly a consideration of what will cast well and for this reason it should be thickened where it joins the heavy tension flange at the end of the throat. This thickening also takes care of the rapid transition of stresses that takes place at this point. At t_1, Fig. 1, it should usually be thickened to carry the shear, as little of the shear is carried by the flanges, and the web is shallow at this point.

In punching large holes in thin plates with a flat-ended punch, the plate gives way at a certain point with a snap. If the head of the machine is heavy and the spring considerable, the kick, due to inertia, reverses the stresses when the plate gives way, suddenly releasing the frame. While this would probably never be enough to endanger the compression flange, yet the reversal of stresses weakens the tension flange.

After having decided upon the material to be used and the allowable stresses in tension, compression and shear, the usual method is to assume the proportions of the main section and calculate for the stress. If the results are not reasonably near the chosen ones, correct the first assumptions and recalculate.

The frame is acted upon by a force W, which produces a bending moment equal to the force times the length of the lever arm. On the main section the lever arm is the perpendicular distance from the line of action of the force W to the center of gravity of the section, and equals $G + Ct$, Fig. 1.

Let:

L, L_1, l, l_1, l_2, etc = lengths of lever arms, in inches, to various sections.

Ct and Cc = distance from center of gravity of section under consideration to extreme fiber of tension and compression flanges respectively.

W = Force, in pounds, applied at the die. (If a hydraulic machine, this is taken equal to the effective area of the ram multiplied by the working pressure per square inch.)

S = Uniformly distributed tensile stress due to force W.

Ss = Shearing stress carried mainly by the web of section.

St = Tensile stress due to moment of force W.

Sc = Compressive stress due to moment of force W.

Smt = Maximum or combined tensile stress.

Smc = Maximum or combined compressive stress.

A = Area of section under consideration.

I = Moment of inertia of section.

M = Bending moment, in inch pounds.

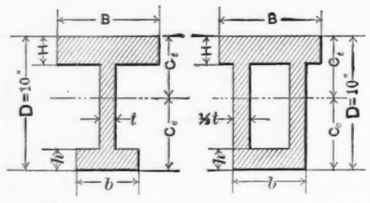
a = Angle of section with center line of frame.

Then:

$M = WL$, WL_1, Wl, Wl_1, Wl_2, etc.

$$S = \frac{W \cos a}{A}$$

TABLE OF THE ELEMENTS OF CAST SECTIONS.



Section Number.	B	H	b	h	t	Ct	Cc	Area in square inches. A	Moment of Inertia. I	Section Modulus for Tension. I/Ct	Section Modulus for Compression. I/Cc	Original Depth. D	Original Material. m	Location of Section.	Load at Die in pounds. W	Distance from Die. l	Bending Moment in inch pounds at Section. M	Maximum Tensile Stress. Smt	Maximum Compressive Stress. Smc
1	6.67	1.39	2.23	.694	.556	2.95	7.05	15.2	166	56.4	23.6	18	C. I.	Per	27,50	10.5	435,000	1,880	2,600
2	5.56	1.53	1.67	.830	.560	2.98	7.02	14.0	148	49.8	21.1	18	S. C.	Per	250,000	5.63	2,750,000	14,940	16,790
3	4.00	1.63	1.50	1.00	.625	3.04	6.96	10.1	141	46.2	20.2	20	...	..	....	....	.....	....	....
4	5.00	1.13	1.50	.750	.500	3.09	6.91	11.4	129	41.6	18.6	20	...	..	....	....	.....	....	....
5	5.56	1.67	1.95	1.110	.560	3.20	6.80	15.4	173	54.1	25.5	9	N. S.	Per	100,000	3.5	637,000	24,140	26,400
6	5.50	1.50	2.00	1.00	.500	3.21	6.79	14.0	164	51.2	24.2	10	...	..	....	....	.....	....	....
7	5.00	1.14	1.82	.680	.450	3.25	6.75	10.6	128	39.3	18.9	11	...	..	....	....	.....	....	....
8	5.56	1.25	1.67	.833	.560	3.25	6.75	12.7	145	44.5	21.4	18	...	..	....	....	.....	....	....
9	4.89	1.56	2.67	.667	.444	3.26	6.74	12.8	155	47.7	23.1	45	...	..	....	....	.....	....	....
10	5.00	1.43	2.14	.714	.540	3.30	6.70	12.9	150	45.5	22.4	7	...	..	....	....	.....	....	....
11	8.90	1.48	3.70	.987	.740	3.33	6.67	22.4	298	89.6	44.8	10	...	..	....	....	.....	....	....
12	10.00	.833	5.00	.833	.833	3.33	6.67	17.4	212	63.6	31.8	10	...	..	....	....	.....	....	....
13	4.55	1.82	2.27	.910	.570	3.45	6.55	14.5	167	48.4	25.5	22	S. C.	Per	360,000	9.2	6,048,000	16,870	17,060
14	6.67	1.67	3.00	1.17	.667	3.48	6.52	19.4	240	68.8	36.7	15	...	..	....	....	.....	....	....
15	5.72	1.43	2.14	1.07	.710	3.50	6.50	15.8	187	53.5	28.8	7	N. S.	Per	57,700	2.5	285,600	23,030	21.500
16	4.89	1.22	2.67	.667	.444	3.51	6.49	11.4	150	42.6	23.0	45	S. C.	Per	300,000	50.	19,737,000	6,390	8,120
17	3.75	1.81	2.08	.555	.694	3.55	6.45	13.2	142	40.0	22.1	72	C. I.	Per	381,600	60.	32.665 000	2,750	3,410
18	4.89	1.17	2.67	.667	.444	3.56	6.44	11.1	148	41.6	23.0	45	S. C.	Per	300,000	50.	19,505,000	6,560	8,120
19	5.00	2.03	2.81	1.25	.470	3.57	6.43	16.8	211	59.0	32.8	16	S. C.	Per	200,000	8.1	2,760,000	16,050	15,870
20	4.89	1.11	2.67	.667	.444	3.62	6.38	10.9	154	42.7	24.1	45	S. C.	Per	300.000	50.	19,880,000	6,740	8,140
21	5.00	2.19	2.81	1.25	.625	3.63	6.37	18.6	220	60.5	34.5	16	S. C.	Per	200,000	8.1	2,782,000	15,330	15,475
22	4.89	1.06	2.89	.611	.444	3.69	6.31	10.6	146	39.6	23.2	45	S. C	Per	300,000	50.	19.980,000	6,910	8,060
23	5.00	1.01	2.86	.595	.476	3.71	6.29	10.8	146	39.3	23.2	42	S. C.	Per	300,000	50.	19,670,000	8,330	9,880
24	7.28	3.64	4.24	1.82	.910	3.73	6.27	38.3	376	101.0	60.0	16 ½	S. C.	Per	360,000	9.25	5,540,000	15,700	17,300
25	5.00	2.00	3.00	1.25	.625	3.75	6.25	18.0	226	60.1	36.1	20	S. C.	45°	360,000	8.93	5.130.000	14,200	14,300
26	7.50	3.44	4.38	1.88	.940	3.76	6.24	38.4	398	106.0	63.8	16	S. C.	45°	360,000	9.00	4,770,000	13,600	15,700
27	5.00	1.88	3.25	1.25	.438	3.81	6.19	16.5	222	58.2	35.8	16	S. C.	Per	200,000	8.00	2,840,000	16,678	14.654
28	5.00	1.43	3.93	.536	.714	3.78	6.22	15.0	190	50.3	30.5	56	C. I	Per	200,000	50.	14,240,000	2,040	2,230
29	3.69	1.85	2.61	.597	.761	3.81	6.19	14.2	182	47.8	29.4	46	C. I.	Per	199,050	28.	9,070,000	2,620	2,520
30	5.00	1.07	2.86	.710	.540	3.84	6.16	12.1	160	41.7	26.0	7	...	..	....	....	.....	....	...
31	6.10	1.95	5.36	.732	.976	3.90	6.10	23.0	288	73.7	47.2	41	C. I	Par	200.000	32.	6,400,000	1,260	1,970
32	6.67	1.50	4.00	1.17	.670	3.92	6.08	19.6	273	69.5	44.8	15	...	..	....	....	.....	....	....
33	6.67	1.67	4.00	1.33	.670	3.94	6.06	21.1	295	74.7	48.6	7 ½	...	..	....	....	.....	....	....
34	6.90	1.55	3.45	1.55	.862	3.96	6.04	22.0	286	72.2	47.4	5 9/10	N. S.	45°	57.700	2.45	235,000	21.510	18,840
35	3.75	1.25	2.50	.729	.521	3.97	6.03	8.6	141	35.5	23.4	48	S. C.	Per	100,000	100.	11,907,000	3.440	5 000
36	10.00	4.17	5.84	2.71	1.25	4.01	5.99	61.4	578	144.0	96.4	12	S. C	Par	360,000	8.1	2,916,000	11,700	17,500
37	6.82	1.82	4.85	1.21	1.21	4.17	5.83	26.8	387	92.8	66.4	33	C. I.	Par	200,000	18.	6,350,000	2,590	1,983
38	5.56	1.11	4.08	.926	.56	4.30	5.70	14.4	216	50.3	37.9	27	S. C.	Per	200,000	50.	12,400,000	14,580	14,600
39	6.28	1.00	4.57	.857	.571	4.32	5.68	14.86	229	53.0	40.3	35	...	...	....	....	.....	....	....
40	7.14	2.50	5.00	2.35	.890	4.36	5.64	34.1	434	99.4	76.8	14	S. C.	Par	360,000	8.5	3,060,000	11,200	14,580
41	6.00	1.10	4.50	1.00	.600	4.44	5.56	15.8	242	54.5	43.5	25	S. C.	45°	200,000	48.7	11,600,000	14,030	16,070
42	6.28	1.00	5.00	.857	.571	4.45	5.55	15.2	239	53.7	43.1	35	S. C.	Par	300,000	47.	14,100,000	6,110	7,530
43	6.74	1.12	5.40	1.12	.670	4.63	5.37	18.9	294	63.5	54.8	22 ½	S. C.	Par	200,000	48.	9,600,000	14,000	15,700
44	6.76	1.22	5.68	1.22	.810	4.70	5.30	21.3	321	68 2	60.5	18 ½	S. C.	Par	200,000	30.	6,000,000	13,900	15.650
45	3.33	.93	2.96	.925	.370	4.82	5.18	8.9	137	28.4	26.5	54	S. C.	Par	....	....	52,432.000	11,740	12.600
46	3.33	.98	2.94	.980	.392	4.82	5.18	9.3	142	29.5	27.4	51	S. C.	Par	....	....	43,975,000	11,200	12,100
47	8.33	1.67	7.50	1.67	1.25	4.84	5.16	34.7	595	123.0	115.0	12	S. C.	Par	200.000	12.	2,400,000	11,300	12,100
48	10.53	1.97	10.53	1.97	1.32	5.00	5.00	49.5	707	141.0	141.0	3 5/10	N. S.	Par	57,700	2.2	126,900	16,350	16.350
49	3.63	1.14	3.63	1.14	.795	5.00	5.00	12.1	194	38.8	38.8	44	S. C.	Par	....	....	33,000.000	10,000	10,000
50	3.63	1.14	3.63	1.14	.91	5.00	5.00	15.3	198	39.6	39.6	44	S. C.	Par	....	....	33,000,000	9,770	9,770

for main section, where $a = o$; $S = \frac{W}{A}$

$$Ss = \frac{W}{\text{area of web}}$$

$$St = \frac{M\,Ct}{I}$$

$$Sc = \frac{M\,Cc}{I}$$

$$Smt = St + S$$

$$Smc = Sc - S$$

The dimensions of the main section being assumed, to determine the center of gravity and moment of inertia: Take the moments of the different areas of the section about some line of reference and divide the algebraic sum of the moments by the total area, which gives the distance of the center of gravity from this line. The neutral axis passes through the center of gravity of the section. The moment of inertia is equal to the sum of the product of each area by the square of its distance from the neutral axis, plus its moment of inertia about its own neutral axis.

As an example, we will consider the design of a 150-ton punch frame, which is to be quite rigid, but as light as consistent with good design; being mounted upon a carriage, gap to reach the center of an 8-foot plate. We will make this frame of a steel casting, of I-section, quite deep, and with medium stresses to insure rigidity. Then

W = 300,000 pounds, and assume:
Smt = 6,000 pounds per square inch.
Smc = 8,000 pounds per square inch.

For main section, referring to Fig. 4:

$5\frac{1}{2} \times 22$	= 121 sq. ins. $\times$ 21	= + 2541
$2 \times 36\frac{1}{2}$	= 73 sq. ins. $\times$ 0	= 00
3×12	= 36 sq. ins. $\times$ 19.75	= − 711

A = 230 sq. ins. $\qquad \frac{1830}{230} = 7.96$

$$121 \times 13.04^2 + \frac{22 \times 5.5^3}{12} = \begin{cases} 20{,}600 \\ 304 \end{cases}$$

$$73 \times 7.96^2 + \frac{2 \times 36.5^3}{12} = \begin{cases} 4{,}616 \\ 8{,}100 \end{cases}$$

$$36 \times 27.71^2 + \frac{12 \times 3^3}{12} = \begin{cases} 27{,}600 \\ 27 \end{cases}$$

Moment of inertia, I = 61,247

$L = G + Ct = 50 + 15.79 = 65.79$

$M = WL = 300{,}000 \times 65.79 =$ 19,737,000 inch pounds.

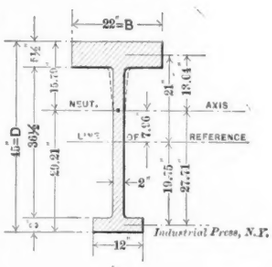


Fig. 4.

$$S = \frac{W}{A} = \frac{300{,}000}{230} = 1{,}305$$

$$St = \frac{M\,Ct}{I} = \frac{19{,}737{,}000 \times 15.79}{61{,}247} = 5{,}085$$

$$Smt = S + St = 5{,}085 + 1{,}305 = 6{,}390$$

$$Sc = \frac{M\,Cc}{I} = \frac{19{,}737{,}000 \times 29.21}{61{,}247} = 9{,}420$$

$$Smc = Sc - S = 9{,}420 - 1{,}305 = 8{,}115$$

These stresses are, therefore, found to be sufficiently near to those which were assumed.

The vertical section is figured likewise, except that there is no direct tension S to combine, but the shear on the web. The section at an angle a has $S = \frac{W \times \cos a}{A}$ to combine. The moment on this section is $M = W L_1$. The vertical section having been determined, the others may be proportioned from it thus: $l : l_1 :: O^3 : O_1^3$, or $O_1 = \sqrt[3]{\frac{l_1 O^2}{l}}$ and all of the other dimensions in like proportion.

Calculate the ordinates O_1, O_2, O_3, etc., and lay them out. The curve found will not be a very pleasing one, and will have to be varied somewhat. Keep the web of a uniform thickness, and taper the flanges in straight lines, keeping the area of the flanges the same as if proportioned from the above formula. Check two or three sections for St and Sc by finding center of gravity and moment of inertia, by method given above. Allow a somewhat lower stress on tension flange of the 45 deg. section and use large fillets for steel.

It is very often the case that two or more sections have to be calculated before the proper sizes are determined, and this becomes a tedious job. In the table herewith are given the elements of fifty different sections reduced to a uniform depth of 10 inches, showing their relative proportions, from which sections may be proportioned to suit almost any condition. From our known values, M, St, and Sc, we get $\frac{M}{St} = \frac{I}{Ct}$ and $\frac{M}{Sc} = \frac{I}{Cc}$. From the columns headed $\frac{I}{Ct}$ and $\frac{I}{Cc}$, we get the value of these quantities for the chosen section at a depth of 10 inches and our new depth will then be 10 times the cube root of the required value, divided by the tabulated value. The depth being determined, all of the other dimensions can be readily figured by direct proportion. If the required depth were 25¼ inches, multiply all of the dimensions in the table by $\frac{25.25}{10} = 2.525$.

Remembering that the dimensions vary as the depth, the area as the square of the depth, the sectional modulus as the cube of the depth, and the moment of inertia as the fourth power of the depth, any of these elements can be readily obtained.

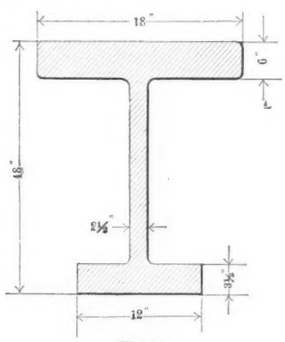


Fig. 5.

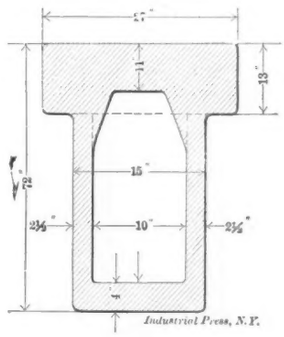


Fig. 6.

The section figured above as an example is No. 16 in the table. No. 35 was originally 48 inches deep. $B = 4.8 \times 3.75 = 18$ inches. $H = 4.8 \times 1.25 = 6$ inches. $b = 4.8 \times 2.5 = 12$ inches. $h = 4.8 \times .729 = 3\frac{1}{2}$ inches. $t = 4.8 \times .521 = 2\frac{1}{2}$ inches. All as shown in Fig. 5. This was the main section of a 100-inch, 50-ton riveter. The maximum stresses are given in the table.

Fig. 6 shows section No. 17 as it was originally built. It was for the main section of a 60-inch gap shear having an 18-inch ram at a working pressure of 1,500 pounds per square inch. The section was calculated as if the tension flange were 27 x 13 inches, the small amount of metal cut out being assumed to be replaced by the thickening up of the side web plates in front.

Sections Nos. 37 and 38 were main sections of an 18-inch 100-ton punch and a 50-inch, 100-ton punch, respectively. No. 45 was a beam 15 feet 6 inches long, carrying a uniformly distributed load of 1,130 tons. In the column headed "location of section," Par. means that the plane on which the section was taken is parallel to the direction of the force at the die; Per. similarly means perpendicular to the direction of this force.

* * *

Another use for cement construction is for curtain walls of expanded metal and cement or plaster to prevent the rapid spread of flame. At the Deering Harvester Plant, Hamilton, Ont., the roof trusses are lathed on both sides with expanded metal, the wall being carried up three feet above the roof, and the laths then covered with one inch of cement mortar.

THE NEWPORT (R. I.) STEAM TURBINE STATION

The first vertical Curtis steam turbine to be installed in this country is a 500 K. W. machine, at Newport, R. I. In the March, 1903, number of the Engineering Edition was a brief description of the Newport plant, with a line-drawing, showing the arrangement of the machinery in the engine room. We are now able to show two illustrations from photographs of this plant, together with detail drawings of the Schmidt independent superheater, with which the plant is equipped. This superheater is of unusual interest, as the work done by William Schmidt in the use of superheated steam in Germany has attracted the attention of engineers all over the world. The superheater of this design is now made in this country by the Providence Engineering Works, who control the patent rights for the United States, and installed the apparatus at the Newport station.

The Newport station is one of several controlled by the Massachusetts Electric Companies, who operate about 900 miles of electric street railways and have already contracted for 33,000 horse power in steam turbines. Three of these are 500 K. W. machines, and will be installed at Newport, while the others will be placed in stations at Fall River and Quincy Point, Mass., and will be much larger units.

The Newport turbine, at present in operation, runs at 1,800 revolutions per minute, taking steam at 140 pounds pressure at the turbine nozzles. Alternating current of 2,500 volts is generated. The turbine is 7 feet 8 inches in diameter at the base, and 12 feet 6 inches high. The station plans call for four turbines in all. The boiler room is equipped with the Schmidt superheater, which may be used or not at will, the intention being to carefully experiment and note the action of the turbines with both saturated and superheated steam. Four 350 horse power Aultman & Taylor water-tube boilers, fitted with Green economizers, will be installed at first. The separately fired superheater stands at one end of the line of boilers, and the arrangement of the steam piping is such that steam can be taken through the superheater or direct from the boilers.

It will be noted in the illustrations that the engine room floor level is above the turbine proper, the generator only being above the floor. A heavy foundation of brick is provided for each unit, the dimensions being 9 feet square at the top, 11 feet at the bottom, and 5½ feet high. Beneath this is an 18-inch bed of concrete.

Fig. 2. View of Gallery in Power Station.

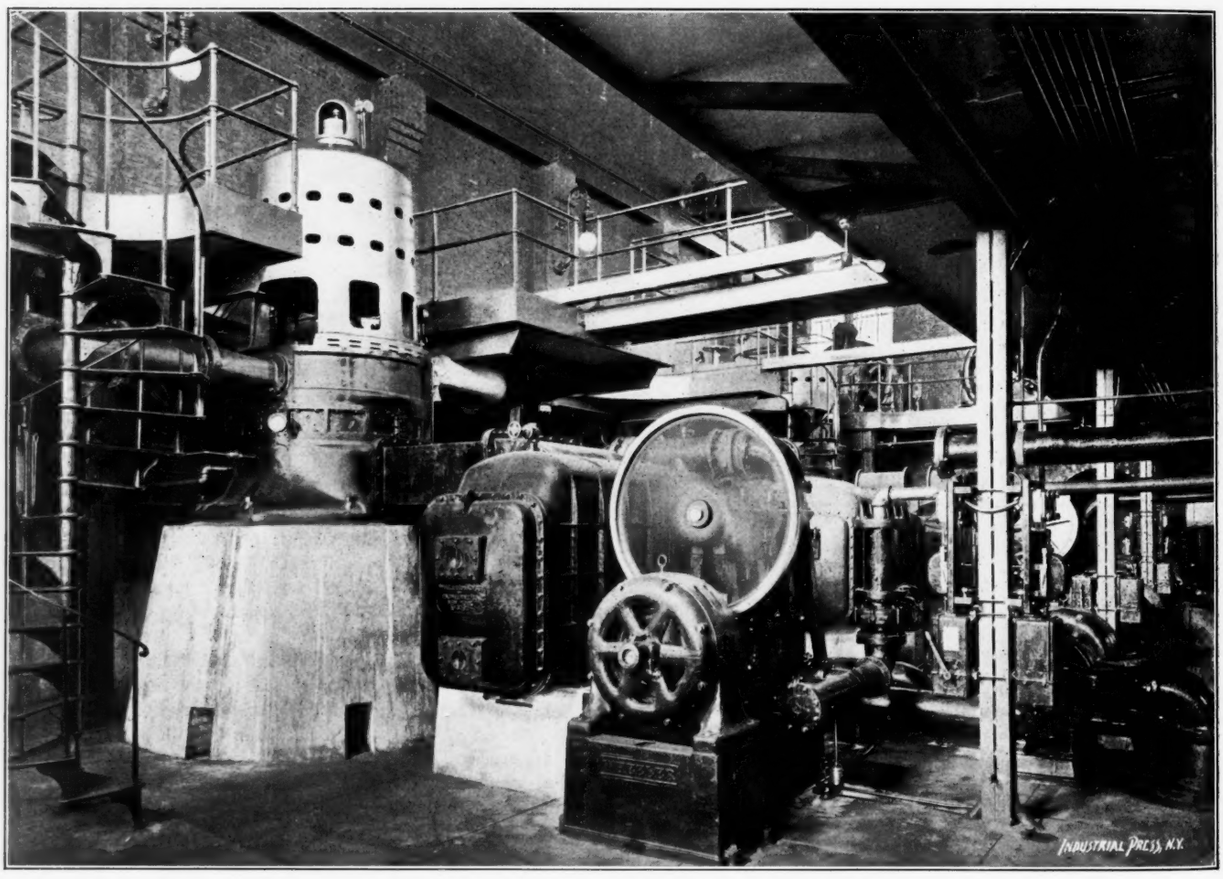


Fig. 1. The New Steam Turbine Station at Newport, R. I.

In explanation of the drawing of the superheater, saturated steam enters through the inlet valve, *A*, and passes through the cast-iron cross pipe, *B*, at the top of the superheater, to which the two upper sets of coils are connected. The satu-

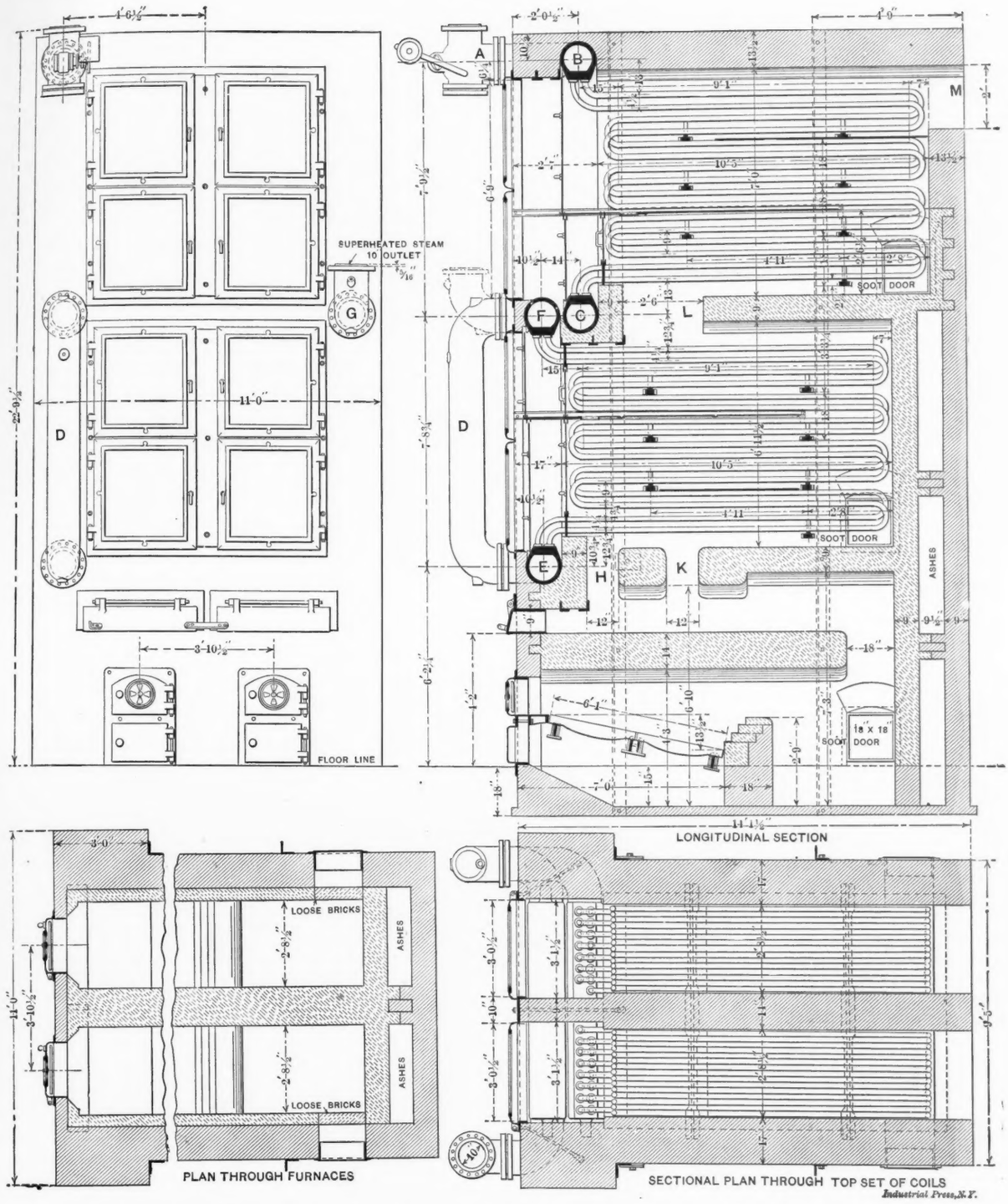


Fig. 3. Details of the Independent-fired Schmidt Superheater at the Newport Station; built by Providence Engineering Works.

rated steam then passes down through these two coils, becoming superheated on the way to the cross pipe, *C;* thence to the pipe, *D*, on the outside of the apparatus, which carries the steam to the bottom of the two lower sets of coils. The steam here enters cross pipe, *E*, and thence passes upward through the lower coils, where it comes in contact with gases at a higher temperature. The superheated steam outlet is at *G*, near the center of the superheater. The object of locating the outlet at this point is to secure as low a temperature of the escaping gases as possible, and at the same time have the heat transmitted to the steam efficiently. This method is a compromise between having steam enter at the top and leave at the bottom, or have it enter at the bottom and leave at the top. The former arrangement would give rather slow interchange of heat and the latter would send the gases up the flue at too high a temperature.

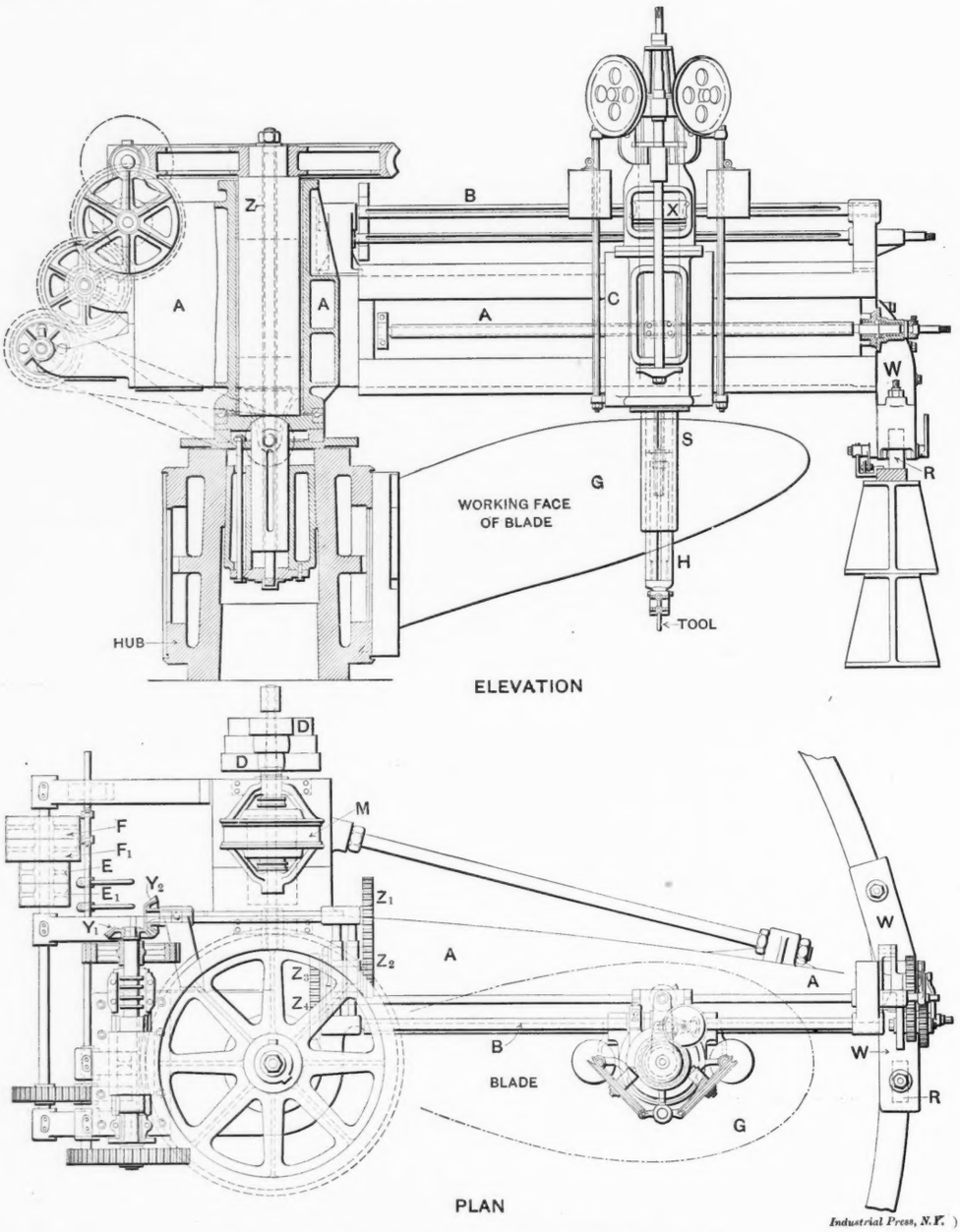
Tests upon this turbine were recently quoted by Mr. A. R. Dodge, in a paper read before the New England Cotton Manufacturers' Association. The tests were run at 140 pounds gage pressure, 250 degrees of superheat, and with the turbine connected to operate condensing. At a load of 500 K. W. the steam consumption was slightly less than 18 pounds per K. W. hour, and it remained nearly constant at this figure for increased loads, up to 800 K. W. At a load of 200 K. W. the consumption was about 20 pounds.

The motors required to operate the circulating and air pumps for the condenser are driven from the turbine generator and this power, about 20 K. W., is included in the output of the machine. Analysis of the velocities obtained indicate that this result from the first vertical unit will be materially reduced. Lighting, railway, and arc load are all carried on the same unit without difficulty.

BAUER PROPELLER-BLADE SHAPING MACHINE.*

The propeller blades of the *Kronprinz Wilhelm* and the *Kaiser Wilhelm II.*, of the North German Lloyd Steamship Company, were shaped to the theoretically correct working face by a shaping machine invented by Dr. G. Bauer, and constructed by the Stettiner Maschinenbau Actien-Gesellschaft, Stettin, Germany, of which concern Dr. Bauer is the chief engineer. The importance of accurately shaped propeller blades has long been recognized, but up to the inception of this machine there has been no means for producing a more accurate surface on large propellers than can be obtained by casting. As an illustration of the need for an accurate shaping machine, a diagram of a propeller blade of the *Kaiser Wilhelm II.* was shown (not reproduced), the inequalities being marked plus or minus according as they are above or below the theoretical working face. As an example, two adjacent points about two feet apart, are noted, one of which was something over one-half inch above the theoretical plane, and the other as much below it, making the total inequality over one inch.

The object aimed at is attained in the machine, illustrated in Figs. 1, 2, and 3, by a planing tool which is reciprocated in helical lines over the blade and progressively fed along its radius after the completion of a cutting and return stroke, as in ordinary planer practice. In this manner a correct helical surface is shaped by concentric helical cuts. The method is applicable for shaping propeller blades to any generating lines. The generating line may be at right angles to the axis or inclined to it, as shown by lines *xy* in *A* and *B*, Fig. 4. It may also be a broken line, with different inclinations to its axis in its different portions.



Figs. 1 and 2. Plan and Elevation of Propeller Shaping Machine.

The half-tone, Fig. 3, shows the machine at work on one of the blades for the *Kaiser Wilhelm II.* The hub is mounted on a cast-iron floor-plate, and the blades are bolted fast in the same manner as they are in actual service, with the working face upward. The stump or pivot, *Z*, Fig. 1, upon which the radial arm, *A*, swings, is fixed in the hub by being bolted to a cone which fits the bore of the hub. The outer end of the heavy arm, *A*, is supported by a carriage *W* provided with two wheels on a guide-path. The rotation of the arm is produced by a worm-wheel, keyed to *Z*, and a worm which is mounted on the arm together with the motor, *M*. The driving mechanism comprises the pulleys, EE_1, FF_1, the step cones, *D*, and the gear trains.

* This, from "Engineering" (London), is a description of a machine of great interest and especially at this time, supplementing, as it does, the article upon the propeller planer in the last number.—EDITOR.

The tool, an ordinary planing steel, is, for reasons presently to be explained, not directly mounted on the tool-holder, *S*, but in a sliding piece, *H*. The tool-holder *S*, moves up and down, and is borne by a carriage, *C*, which travels along the radial arm, *A*. In shaping the propeller blades, *G*, the tool describes helical lines, as was already pointed out. Having made one cut, the tool travels back to the starting point of its operating stroke, following the same path. The forward feed is then imparted to the tool, which now makes a fresh cut, is taken back and again advanced, and so on. The operation is therefore the same as in a shaping machine, except

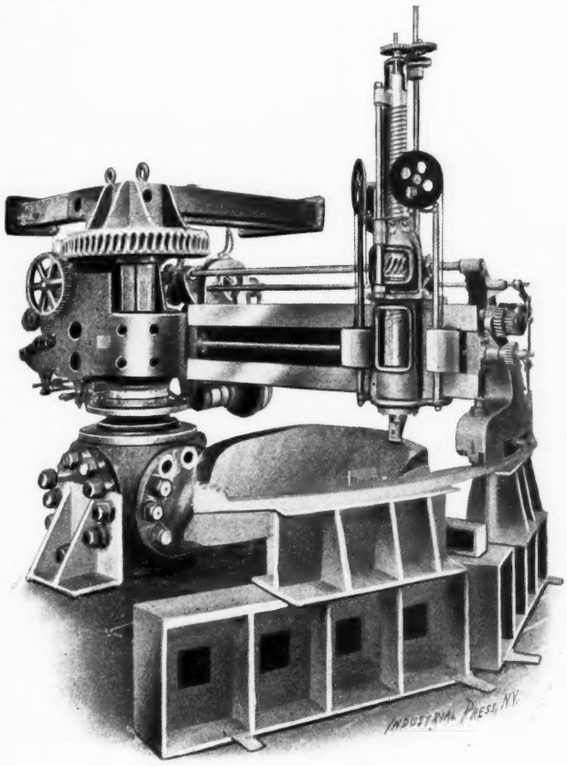


Fig. 3. View of Shaper at Work on the Blade of a Large Propeller.

that this new machine moves in helical and not in straight lines. This helical motion is produced by the combination of the up-and-down movement with the rotary movement of the arm, and the pitch of the helix depends upon the adjustable ratio of the two velocities. The vertical movement of the tool is obtained with the aid of a helical thread, cut upon the tool-holder, *S;* this thread engages with the worm-wheel, *X*, fixed in the carriage, *C*. The worm-wheel is driven through the intermediation of the shaft, *B*, the toothed wheels, Z_1,Z_2,Z_3, etc., and the bevel wheels, Y_1,Y_2, from the main worm which rotates the arm, *A*. It will thus be clear that the two movements of the tool—the vertical movement of *S* and the rotation of the whole arm, *A*—are independent of each other, and that the ratio of the two velocities can be varied with the help of the change-wheels, Z_1,Z_2, etc. It is in this way that the machine is set for cutting helical surfaces of different pitches. The reversing mechanism of the machine, which returns the tool to the starting point of its stroke, does not differ from the construction usually to be met with in large modern planing machines.

The feed of the carriage, *C*, along the arm, *A*, is produced by a tappet attached to the guide-path; or what practically amounts to the same thing, the precise construction being a roller attached to the ratchet feed levers, which runs on a stop. For the simple form of propeller in which the generating line is at right angles to the axis, shown at *A*, Fig. 4, the requirements are satisfied by feeding the carriage radially along the arm, *A*, in whatever ratio as determined by the pitch of the propeller. But when the generating line is inclined to the axis as at *B*, Fig. 4, the conditions become slightly more complicated, because it is necessary to provide for axial movement of the tool to correspond to the inclination of the generating line. That is, the axial movement must equal the tangent of the angle made by the generating line with the line at right angles to the axis. In the case of the *Kaiser Wilhelm II.* the diameter of the propeller from tip to tip of the blades is 22 feet 8 inches and the radius is, of course, 11 feet 4 inches. The angle made by the generating line is such that the tips of the blades are separated from the right angle line nearly 26 inches, and it is to compensate for this departure of 26 inches in a radial distance of 11 feet 4 inches, or any other diameter, that the movement about to be described, is introduced.

As already mentioned, the tool is not directly mounted in its tool-holder, *S*, but in the sliding piece, *H*, which can be displaced within the tool-holder by the aid of a screw spindle. In order to ensure the desired inclination between axis and generating line, the proper ratio has to be maintained between the axial and the radial feed. In the case illustrated, the tool is, at the completion of each stroke, raised by the distance, s_1, and advanced outward by the distance, s_2, thus producing a blade surface in accordance with the generating line, *xy*. The spindles for imparting the radial and the axial feeds must be in positive connection, and special gearing is provided for this purpose. The tool itself is an ordinary cutter-bar, whose cutting edge is suitably inclined to the face upon which it works. Since, however, the surface slope diminishes as we approach the top of the blade, it might be thought that the tool would frequently have to be changed during the shaping of one blade. As a matter of fact, however, a blade may almost be completed with one tool, provided the cutting angle be suitably adapted to the average slope of the blade. The tool is, of course, pivoted as in a planing machine, so that it can be deflected during its return stroke, and glide over the blade without meeting any resistance.

The machine represented in the photographic view can deal with screw propellers up to 23 feet in diameter. The pivot, *Z*, about which the arm, *A*, turns, has a diameter of 15¾ inches, and the arm a length of about 13 feet, measured from center to center. When the machine has been mounted in the hub, the height from the upper edge of the bedplate to the upper edge of the worm-wheel is about 10 feet 9 inches; reckoned up to the highest point to which the change-wheels may reach, the height is about 16 feet 6 inches. Complete with bedplate and guides, the machine weighs 40 tons. With a feed of 1-25 inch the machine can, without difficulty, take a cut ¼ inch in thickness. A blade of the *Kaiser Wilhelm II.*

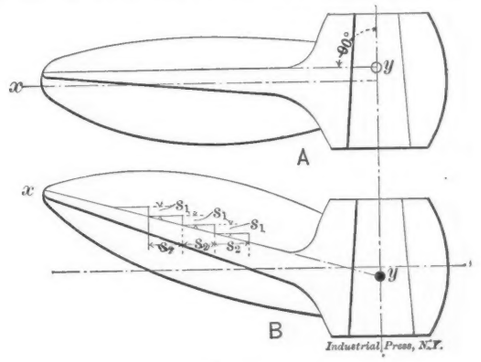


Fig. 4.

was shaped in 150 hours, a roughing as well as a finishing cut being made in this time. The blade has a length of 8 feet 3 inches, and a surface of nearly 37 square feet. Only one man is required for attending to the machine. In setting up the work a blade is located by shifting it on the studs securing it to the hub, until the pitch is as nearly uniform as possible all over the face. Turning the blade to accommodate the conditions is permitted by the slotted holes for the studs, this being the usual practice to permit slight changes to be made in blade-pitch, if found desirable after the test runs have been made.

* * *

In one American shop that we know of, the metric system is used on special work without trouble by simply directing the workmen to measure "so many marks" on a metric scale without any attempt at converting distances into feet and inches.

SUDDEN DEATH OF ROBERT H. THURSTON.

As we go to press with the last form of this number, the announcement comes of the sudden death of Dr. Robert H. Thurston, Director of Sibley College of Engineering, Cornell University, on the evening of October 25th. Dr. Thurston was sixty-four years old on the day of his death, and had invited several members of the faculty of Cornell University to take dinner with him in honor of his birthday. He had just returned from a walk on the campus and was awaiting his guests in the drawing-room of his residence when suddenly he fell into a stupor, and died shortly after from heart disease.

Dr. Robert H. Thurston.

Robert Henry Thurston was born in Providence, R. I., in 1839, the son of Robert L. Thurston, one of the first builders of steam engines in this country. He was educated at Brown University, being graduated from there in 1859. He was employed in his father's shops until the beginning of the Civil War, when he joined the engineering corps of the United States navy. He served on several vessels during the war, and for gallantry and commendable service as an engineer was twice promoted, and toward the close of the war received his commission as first assistant engineer.

At the end of the war he was appointed a professor at Annapolis. He resigned his commission in the navy in 1872, having previously accepted an appointment to the chair of mechanical engineering in the Stevens Institute.

In 1871 Dr. Thurston became Professor of Engineering at Stevens Institute of Technology, Hoboken, N. J., and his fifteen years of service there showed him to have executive ability of a rare order, and profound technical knowledge. During his stay at Stevens he, in conjunction with President Morton, did much to advance the fame and standing of the Institute among mechanical engineers, both in this country and abroad. In 1885 he was called to Cornell University to take the directorship of the then newly organized Sibley College of Engineering, and his administration there has been phenomenally successful.

Dr. Thurston was the first president of the American Society of Mechanical Engineers, and has contributed a large number of papers to the proceedings of this society, probably more than any other author. He was highly talented both as a speaker and a writer, and was able to express himself with such ease and fluency that it was always a pleasure to listen to him or to read his writings. Nowhere was his remarkable grasp of affairs and his capabilities as a worker more evident than in these writings, which followed each other in rapid succession, and yet were in most cases of great merit. This was particularly so in some of his more recent papers in which he summarized the state of the art with respect to certain important engineering questions, like steam jackets, superheated steam, the steam turbine, etc.

The text books from the hand of Dr. Thurston were many, the best known being his volumes on the materials of construction, steam boilers and steam engines. Another book that has had a large sale was his "Friction and Lost Work in Machinery." As a text-book writer he often collected and summarized the conclusions of others rather than confining himself to his own personal investigations; and in this respect was frequently criticised. But his grasp of engineering subjects was so secure and his ability for drawing fair conclusions so good, that we consider it fortunate, rather than otherwise, that he saw fit to collect the great number of data that he did and place them where they may be conveniently referred to.

As a teacher Prof. Thurston was able to inspire his students with high ideals and always insisted that they should take up engineering on a broad gage plan. While he undoubtedly appreciated the necessity for careful attention to the details on the part of the engineer, he also knew that the engineer who has to achieve distinguished success must also be a man of affairs, and have a knowledge of men of affairs and of their ways. This spirit of broadmindedness, which he himself had, and attempted to inculcate into his students, was probably the distinguishing characteristic of Dr. Thurston.

* * *

THE GREAT CATHEDRAL COLUMNS OF NEW YORK.

The great columns for the Cathedral of St. John the Divine, New York City, are the largest monuments composed of one or a few pieces of stone ever built in this country. They are monuments because each one is a memorial, the expense of which was defrayed by some wealthy person. It was originally intended that these should be monoliths and over two years ago we published a description of the immense lathe that was designed for turning the great blocks of stone and converting them into cylindrical columns. The failure of the attempt to turn them in one piece has also been discussed in this journal. One or more of the columns broke before being finished, probably because no center rest was provided for supporting the stone midway between head and tailstocks, and it was decided finally to make the columns of two pieces each. The lower and larger piece in each case is 38 feet long and 6 feet diameter and weighs upward of 90 tons. Next in size in the way of a home product are the front columns of the New Hall of Records, New York; but these are only 36 feet long and 4 feet 2 inches diameter, weighing 40 tons, or less than half the weight of the largest stones in the columns of the Cathedral of St. John the Divine.

Comparisons with other large monuments of the world, show that Americans, with their advanced methods and improved machinery, are still far behind in stone working. Figures published by the *Philadelphia Record* show that the obelisk in Central Park, New York, is 69 feet high, 7 by 8 feet in cross section at the base, and weighs 220 tons. It was quarried more than 3,500 years ago, without the aid of any except the simplest mechanical devices. Largest of all the obelisks is the one at Rome, which is 108 feet tall, 8 feet square at the base and weighs 450 tons. At Karnak, Egypt, there is a great column which weighs 297 tons. It is 60 feet high and 11 feet in diameter. In Rome, again, is Trajan's Stone, a stupendous column 127 feet 6 inches high. It weighs 300 tons. Cleopatra's Needle, in London, a companion to our obelisk, is 71 feet high and has a base of 7 feet 7 inches. It weighs more than ours. In Alexandria is the famous Pompey's Pillar. It is 104 feet tall, and weighs 400 tons.

* * *

The theoretical water power of the world has been thus roughly computed by John Clarke Hawkshaw, of the British Institution of Civil Engineers: Assume a depth of 10 inches of rainfall to flow off each square inch of land surface, the mean height of which may be taken as 2,250 feet above sea level. Then the water from the whole surface falling through the mean height would give 10,340,000 000 horse power in perpetuity. Our present yearly output of 225,000,000 tons of coal would give that horse power for only a day under very economical conditions.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

For the past year or so, interesting experiments in high-speed electric traction have been conducted on the Berlin-Zossen military railway, which was specially constructed for high-speed work. Announcement was made by cable October 6 that the experimental car had attained a speed of 125.8 miles per hour without damaging the roadbed or machinery. The experiments made last year were unsatisfactory, as the roadbed was not equal to the stress imposed on it by high speed. The attempt will now be made to increase the speed to 140 miles per hour. The current is three-phase at a pressure of 13,000 to 14,000 volts and is reduced by transformers on the car to 450 volts. The car has four motors, giving an aggregate motive force of nearly 1,100 horse power. The results so far reached have led the engineers, it is said, to recommend a speed of 93 miles per hour for commercial purposes on the State Railway between Berlin and Hamburg.

The most persistent experimenter, as well as the most scientific investigator, in regard to aerial navigation in this country has been Prof. Langley, the secretary of the Smithsonian Institute, Washington. His many years of effort, however, have again resulted in failure the past month. His aerodrome, perfected as far as his knowledge would permit, was launched into midair from a high staging, hovered uncertainly for a moment, and then plunged downward into the Potomac. It is said that the total failure of this trial was due to a certain part of the mechanism catching when gliding along the launching ways. Prof. Langley has conducted his experiments in part under government aid, though we do not know on what grounds the appropriation for this purpose was made. While he may not live to see human flight a reality, or even a reasonable possibility, it is certain that his efforts will have contributed materially to our store of knowledge on the subject of flight, and his many attempts, even if failures, are but steps to be expected in dealing with a problem of almost infinite difficulty.

The power plant equipment for the New York terminal of the Pennsylvania Railroad for operating the trains in the projected tunnel under the North River is to consist of Westinghouse-Parsons steam turbines of the horizontal, short-barreled type. There are to be three turbines, each of approximately 7,400 electrical horse power, which will drive 5,500-kilowatt three-phase, alternating-current generators, operating in parallel. Their overload capacity will be over 11,000 horse power and each turbine will be provided with a by-pass automatically controlled by the governor to accommodate abnormal fluctuations in load. This will also permit operation at full load, non-condensing. The turbine equipment will operate under conditions favorable to the attainment of high economy, viz.: 200 pounds steam pressure at the throttle, 28 inches vacuum and 175 degrees F. superheat. The generator will be direct-connected to the turbine shaft through a flexible coupling, each section of the unit having two bearings of ample proportion, thus avoiding shaft stresses. The three-phase winding will deliver current directly to the distribution system at 11,000 volts, no step-up transformers being employed.

The introduction of blueprints into the United States was not such a rapid process as the present universal adoption of this method of copying tracings might indicate, says the *Engineering Record*. The first prints of this nature shown in the country were part of an exhibit in the Swiss section of the Centennial Exposition, and it was stated by one of the gentlemen in charge of that exhibit that the process had but recently been introduced into Switzerland from Germany. Mr. Rudolph Hering was requested to prepare an article for the proceedings of the American Society of Civil Engineers on the Swiss display, and came across these prints while engaged on this work. He obtained a copy of the formula for the solution, and after some trouble secured the ingredients and tried the process at his home. This was in 1876, and was probably the first case of blueprinting in the United States. He sought to interest the city engineer of Philadelphia in the process, but Mr. Smedley, who then held the office, refused because the operations would be too sloppy. Then he showed some of his prints to Dr. Coleman Sellers, but that eminent engineer refused to see anything good in them. Workmen, he said, were so accustomed to working from drawings in black ink on white or brown paper that the attempt to introduce drawings with white lines on a blue background would be the cause of serious trouble.

In a consular report reference is made to a type of oil engine developed abroad in which the oil is vaporized and ignited without the use of any external source of heat. The main drawback has been that the engine would not run indefinitely with light loads, owing to the explosions not occurring with sufficient frequency to keep the igniting portion at a sufficiently high temperature. A modification of this type of motor brought out by the Britannia Company, of Colchester, England, is claimed to be free from this drawback. The vaporizer is arranged, as usual, at the back of the cylinder. On the suction stroke a vapor valve is opened by the cam shaft, and through this valve air is drawn into the cylinder through the vaporizer, into which at the same time a little oil is sucked through an automatic valve. This mixture of air and oil is in itself too rich to be explosive and the main supply of air is drawn through a separate air valve into the cylinder. Two passages connect the vapor valve with the cylinder. One of these is large and straight, while the other is narrow and U-shaped. The lower portion of the U contains the igniter—a piece of metal having ribs, which enable it to absorb heat readily when the explosion takes place. This piece therefore becomes and remains red hot, while the rest of the vaporizer is only at a black heat. The vapor which is drawn through this igniter on the suction stroke is far too rich to burn, but on the compression stroke air is forced back into the igniting piece and provides the necessary oxygen for the vapor already there to ignite. None of the exhaust passes through the igniter, which is consequently not cooled down in the case of a missed explosion. The proportion of oil and gas used is regulated by throttling the air supply. As already stated, part of this air is drawn through the vaporizer and the rest through the air valve. If the admission to the latter is throttled a greater proportion of the air used will be taken through the vaporizer and will carry with it a proportionately greater amount of oil. The makers claim that, once started, the engine will run absolutely without attention for several hours.

SHOCKS FROM ELECTRIC LOCOMOTIVES.

Street Railway Journal, August 22, 1903, p. 247.

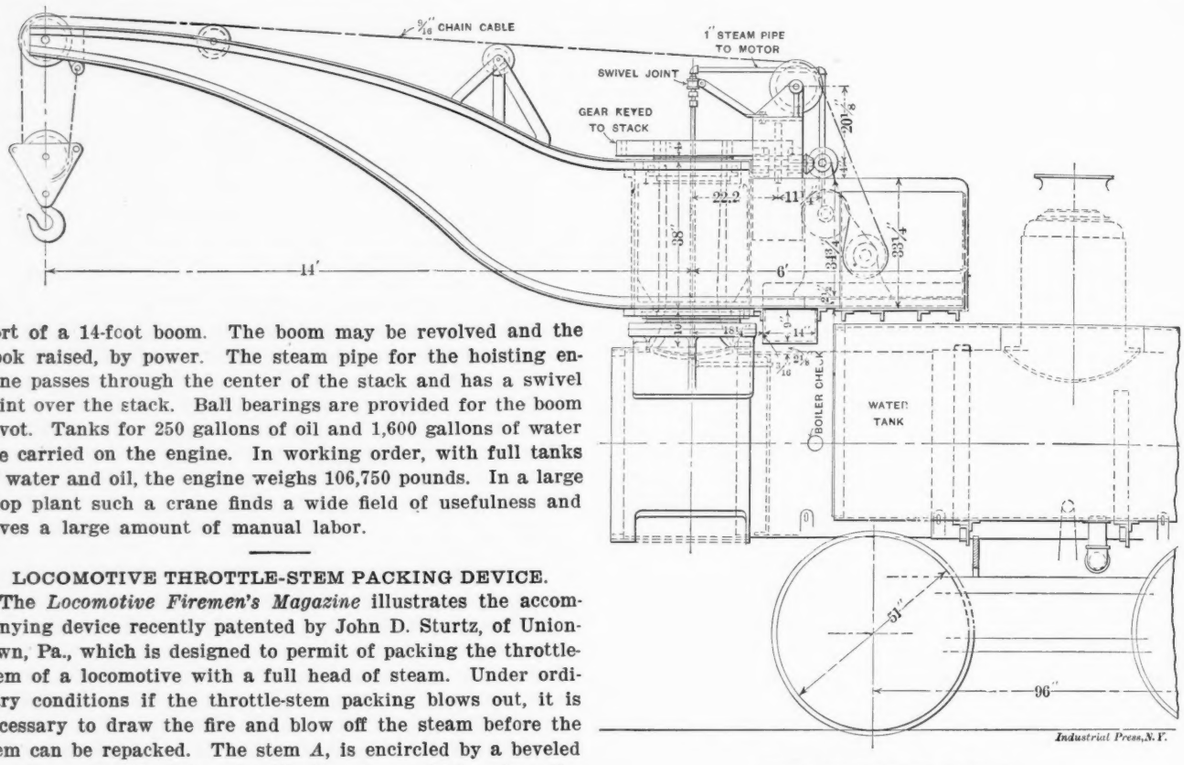
Electric locomotives or cars having voltages more dangerous to life than the common 600-volt direct-current are few as yet, but with the introduction of alternating current their number will increase; and it is in order to call attention to one element of danger in their operation which cannot be too carefully guarded against. It is a danger for which prevention is easy, but is nevertheless a real one, and has already resulted in at least one serious accident in this country. We refer to the possibility that a locomotive may run onto a portion of track covered with sand or dirt, so that there is a partial insulation between the wheels and rails. In such a case, if the locomotive is running on a grounded circuit, using the rails as a return, there is an excellent chance for employees to receive serious shocks in attempting to board the locomotive, because there is likely to be a dangerous voltage between the locomotive frame and ground. Shocks from this cause have not been unknown in street railway practice, but the voltage is usually not dangerous to life on a street railway system, and there is considerable insulating wood in the make-up of a car. On an electric locomotive, using high-tension electric current, and having a steel frame, however, a shock of this kind is almost certain to be attended with disagreeable consequences. Although the possibilities of a shock

from this cause are apparent, consideration is not usually given to the danger, so we feel justified in uttering this warning. One obvious remedy is to omit the sand boxes from such a locomotive's equipment, and furthermore, if the locomotive is ever to operate on dirty rails, it should be equipped with a set of brushes for brushing the rail in advance of the wheel.

SWITCH ENGINE EQUIPPED WITH CRANE.

American Engineer & R. R. Journal, October, 1903, p. 391.

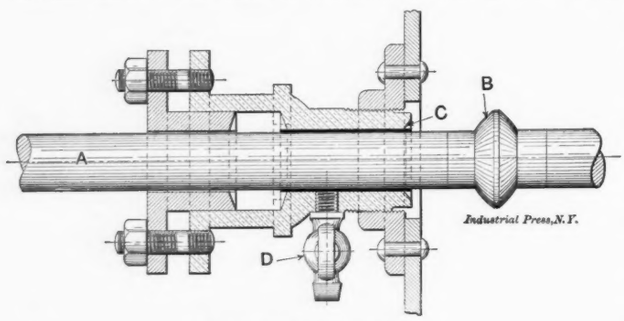
A convenient locomotive crane of four tons lifting capacity has been fitted up at comparatively little expense at the Topeka shops of the Atchison, Topeka & Santa Fe and will be used about the locomotive shops and yards. An old four-wheel switch engine was equipped to burn oil (so that it may safely enter the buildings) and fitted with a substantial cast-iron stack, with a large base, forming the pivot and support of a 14-foot boom. The boom may be revolved and the hook raised, by power. The steam pipe for the hoisting engine passes through the center of the stack and has a swivel joint over the stack. Ball bearings are provided for the boom pivot. Tanks for 250 gallons of oil and 1,600 gallons of water are carried on the engine. In working order, with full tanks of water and oil, the engine weighs 106,750 pounds. In a large shop plant such a crane finds a wide field of usefulness and saves a large amount of manual labor.



Crane Attached to Switch Engine.

LOCOMOTIVE THROTTLE-STEM PACKING DEVICE.

The *Locomotive Firemen's Magazine* illustrates the accompanying device recently patented by John D. Sturtz, of Uniontown, Pa., which is designed to permit of packing the throttle-stem of a locomotive with a full head of steam. Under ordinary conditions if the throttle-stem packing blows out, it is necessary to draw the fire and blow off the steam before the stem can be repacked. The stem *A*, is encircled by a beveled ring *B*, preferably integral with the stem, which, when the throttle is opened to the full extent, bears upon the beveled seat *C*, and shuts off the flow of steam or water into the stuffing-box cavity. The stem is swiveled so that it can be rotated without disconnecting the lever, the object of this being to grind off any scale that may have settled on the seat *C*. To pack the throttle all that is necessary to do is to place the engine so that the cranks on one side are on a center, disconnect the slide valve-rod from the rocker, and cover the steam ports with the valve. The ports on the other side can be covered by placing the reverse lever in the middle notch of the quadrant. The throttle lever can then be pulled wide open without admitting steam to the cylinders. The pet-cock, *D*, is a telltale by which the engineer can determine whether the ring, *B*, is seated tightly enough to make it safe to loosen the nuts and remove the gland.



Packing for Throttle Stem.

The principle of the device is identical with that of the Jenkins valves; these can be packed under full pressure when open by screwing the valve upward until it abuts against the under side of the stuffing-box, thus shutting any flow through the gland.

THE REASON FOR THE VERTICAL DESIGN OF THE CURTIS STEAM TURBINE.

Extract from Paper read by W. L. R. Emmet before the American Street Railway Association, Saratoga, N. Y. September 2-4, 1903.

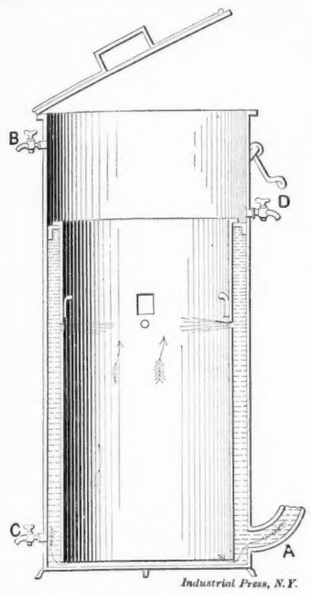
The question as to why the vertical shaft design was adopted for this unit (5,000 K. W. unit for Chicago station, 25 feet high, 14 feet in diameter and weighing 400,000 pounds) has often been raised and many doubts and criticisms concerning it have been expressed. It is not easy to explain all the reasons which led up to its adoption but it may be said that the compactness and simplicity of this unit, which are its most marked characteristics, are largely due to the merits of this design. With the vertical shaft arrangement all lateral strain is removed from the bearings which align the shaft and all deflection of the shaft is avoided with a minimum number and length of bearings. This matter of properly supporting a shaft and keeping it exactly central and in perfect alignment is an important one where small clearances are desirable with a large diameter in the revolving part. To carry such weights as are necessary in the revolving part of this large unit many very large bearings would be required if the shaft was in a horizontal position. An elaborate system of forced lubrication with artificial cooling would be necessary in connection with these bearings, and a failure of any of these bearings would occasion serious danger to the operation of the machine. If the machine were built in a horizontal position it would be very difficult to so support the wheels that their clearances would not be affected by sagging of shaft or looseness in bearings, and also, it might be difficult to place them with such a relation to each other that the clearance would not be affected by expansion of the shaft. In the vertical design the space between wheels is reduced to a minimum, the supporting

structure is perfectly symmetrical and cannot be in any way distorted or put out of line either by mechanical or steam pressure strains or by the effects of expansion.

STEEL HARDENING APPARATUS.

Zeitschrift fur Werkzengmaschinen und Werkzenge, June 5, 1903, p. 371.

After a number of trials and experiments, Louis Bahner, of Berlin, has brought out an apparatus for hardening steel that is said to overcome the well-known troubles and difficulties surrounding that class of work. The treatment depends upon the fact that the object is to subject the whole piece to a continuous stream of water forced into a tank, in such a way that an equal and uniform hardening is obtained. As the result of the contact of the red hot piece of metal with the surrounding liquid, it is well known that a steam envelope is formed about the former, which prevents the access of the water to the hot surface and thus checks the hardening process. Even by moving the piece about in the water this difficulty is not altogether obviated; for, if a closer contact of the hardening liquid is obtained on the side toward which the piece is moving, there is still the existing steam pressure on the other side.



Hardening Tank.

The illustration shows one form of the apparatus referred to, as designed for large pieces. The water is delivered through the pipe *A* and enters the inner cylinder at four points, opposite where the piece to be hardened should be placed, and flows out at *B*. In smaller designs the water is admitted at the bottom only. The object is to cause a current of water of uniform temperature to flow evenly over all of the surfaces of the submerged piece and thus produce a constant rate of cooling at all points.—G. L. F.

ELECTRIC CONTROL OF COMPRESSED AIR BRAKES.

Annalen fur Gewerbe und Bauwesen, May 1, 1903.

The electro-pneumatic system of controlling air brakes, as exploited by the Siemens Company, permits a simultaneous action to be obtained at all points on a train. The brakes upon each car act automatically whenever the pressure in the train pipe is lowered below a fixed point. No change is made in pre-existing arrangements and the apparatus can be worked as before when the electric apparatus is cut out.

Valves are put into a pipe leading from the main train pipe to the brake cylinders. These valves are kept closed by the air pressure, but can be opened by the action of electro-magnets and thus cause an application of the brakes. The current is sent through the magnets by a switch attached to the handle of the engineer's valve, and similar switches and cocks are placed in each of the cars to be used in case of emergencies.

A switch operated by a piston which is subjected to main train pipe pressure upon one side and is balanced by a spring on the other, serves to close the circuit, if, for any reason the train-pipe pressure is lowered; so that the brakes are at once applied. A complementary arrangement serves to apply the brakes in case of any breakage of the wires or short-circuiting.

The following advantages are claimed for the system: The brakes are applied without shock to the train, regardless of their length or speed, or whether the application is made from the locomotive or a car; the efficiency of the braking is independent of the distribution of braked cars throughout the train, while the purely pneumatic system is dependent solely upon the unbroken succession of braked vehicles; the electric control at once utilizes the train-pipe pressure without permitting it to escape, thus reducing the consumption of compressed air; the conditions of brake application since it takes place in case of a break-in-two as the result of the action of either the pneumatic or electrical portion of the apparatus and the engineer can test the brakes without leaving his place or requiring assistance.

A battery of twenty cells supplies the current for the operation of the device.—G. L. F.

ELECTRIC SOLDERING.

Moniteur Industriel, September 12, 1903, p. 574.

This process of electric soldering is especially adapted for use in foundries and steel works and is giving excellent results in practice. It was developed and is in use by the Societe d'Electricité et d'Hydrauliques, at Charleroi, France. It consists of causing an arc to play between the piece to be soldered and a bar of soft iron. It effects a great saving over those methods of soldering where an oxyhydrogen flame is used or of those where molten metal is caused to flow over the part to be filled.

A complete installation for the work consists of a direct current generator; a switchboard, a secondary switchboard upon which the soldering apparatus is placed; a rheostat and the soldering apparatus. The dynamo is a direct-current machine with a capacity of 26 effective kilowatts and developing 400 amperes under a normal tension of 65 volts. The induction coils are so wound that they can sustain a considerable overload, the amperage rising suddenly from 0 to about 1,200 at the instant of production of the arc. The dynamo can also work without sparking from 0 to 1,200 amperes.

In the operation the workman holds a sheet of violet glass in one hand, both to protect himself from the effects of the arc and to enable him to adjust the soldering apparatus to exactly the right place. With the other hand he manipulates the apparatus proper, which consists, according to the weld that is to be made, of a bar of iron or carbon fastened to the end of a wooden handle that is fitted with a guard to protect the hand. The work consists of causing an arc to play between the piece to be soldered and the soldering bar, and can be done in one of two ways. Iron filings can be put into the hole to be filled and then melted by means of an arc made to play between it and the solid metal, more filings being added until the hole is filled. A carbon welding bar cannot be used when the parts are to be machined, as the results leave the metal harder than the original piece.

The second method is to cause the arc to play between the piece to be soldered and the soft iron bar. The latter is melted by this operation, lowers the temperature of the arc and furnishes the material needed for the soldering. This lowering of the temperature of the arc avoids overheating the metal.

These operations require the services of two men; one handles the soldering apparatus while the other changes the bars, adds the filings and hammers the metal when the arc is cut off. When the soldering is well done a perfect union of the metal that has flowed in with that of the main piece is obtained, for the two are united while in the liquid state—a condition that does not obtain with the ordinary methods of doing the work. The saving effected by this method is very great as compared with the use of the oxyhydrogen blow pipes or fused metal, while in many cases it makes it possible to effect repairs upon defective pieces that would otherwise have to be consigned to the scrap heap on account of the trouble and expense involved in doing the work.—G. L. F.

THE RATEAU STEAM TURBINE.

A. Rateau, in Engineering Magazine, Oct., 1903, p. 49.

The Rateau multi-cellular turbine, the result of an especial study of the subject by the writer, was briefly described in 1900, in a report presented by him upon the subject of steam turbines at the International Congress of Applied Mechanics at Paris in July, 1900. In designing this machine it was sought to satisfy the following conditions:

1. The attainment of a high mechanical efficiency, together with as low an angular velocity as possible.

2. The provision of a large, and at the same time non-injurious clearance between the fixed and the moving parts.

3. The attainment of the least possible weight of the whole machine, and especially of the rotating parts.

The revolving wheels are formed of disks of thin sheet steel, as shown in Fig. 3, carrying cylindrical buckets on the periphery, these buckets being riveted to a band of steel welded to the disk. This gives a very light and strong construction, maintaining its balance at all speeds. The guide buckets are fixed in circular diaphragms, secured at the periphery in grooves cut in the interior of the turbine case. There is thus left between the successive diaphragms a series of annular chambers in which the revolving wheels are placed, Fig.

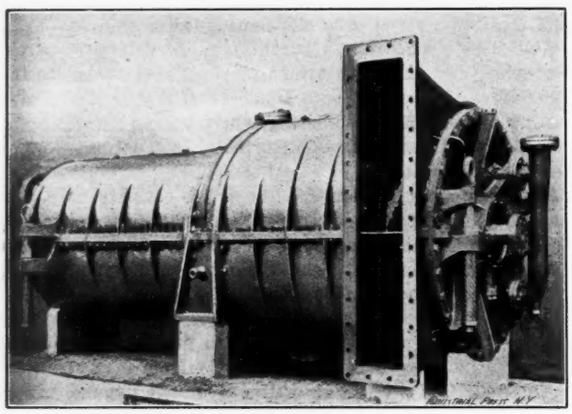


Fig. 1. Rateau Turbine.

2. The shaft passes through bushings fitted in the diaphragms, there being but little play or clearance. Between the fixed and revolving portions of the turbine, however, the clearance may readily be made as much as 5 or 6 millimetres, without injury. The main bearings of the shaft are generally outside of the casing, a special form of stuffing box being employed, assuring tightness against leakage. The external appearance of the machine is shown in Fig. 1.

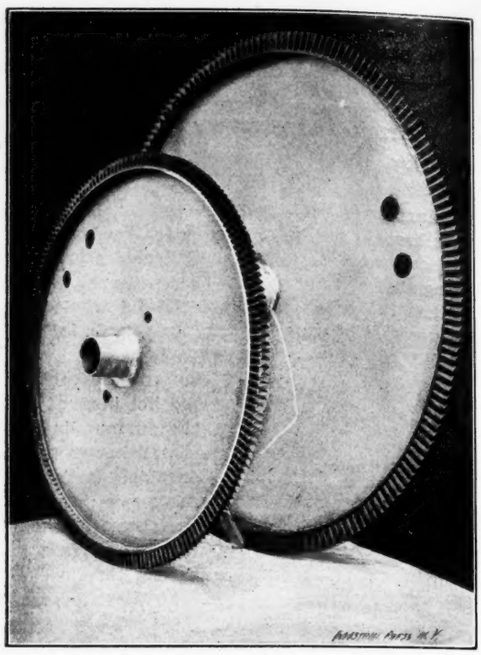


Fig. 3. Two of the Rotating Turbine Disks.

PLATING PROCESS.

Engineering News, August 27, 1903, p. 192.

A peculiar plating process is being employed in Germany to produce sheet-metal consisting of several layers of different metals. The process utilizes the adhesive qualities of aluminum at moderate heat. A typical product is a sheet of iron (soft steel) coated on both sides with copper, the completed sheet having about 15 per cent of copper. Such sheets can be used as a roof-covering, either plain or corrugated, in place of copper on wood, or in place of galvanized iron. The process of making such plates is as follows: A copper plate is cleaned and roughened by sand blast, and is then rubbed over with a piece of aluminum, which

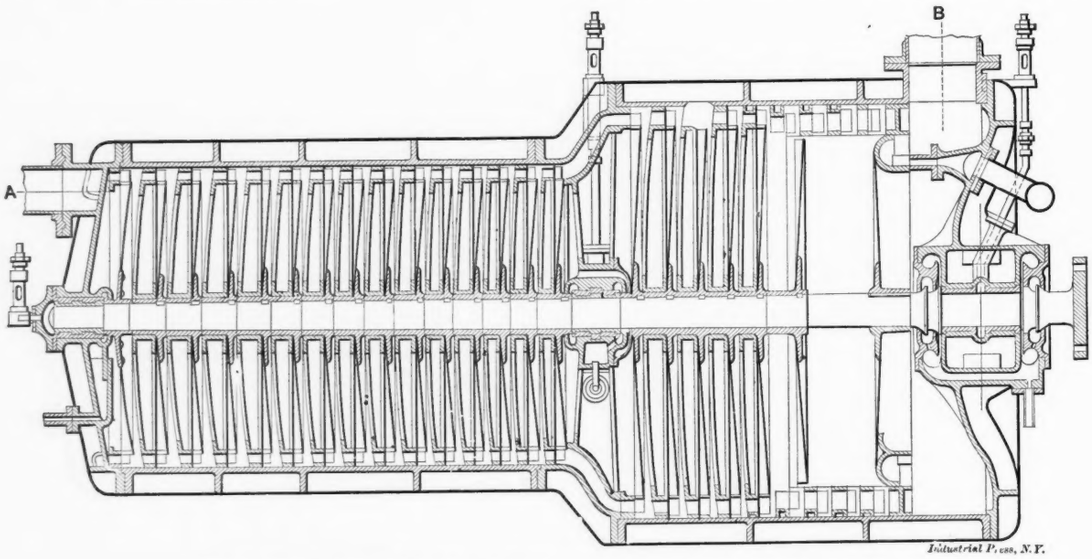


Fig. 2. Sectional Elevation of Rateau Turbine. Steam Enters at A and Exhausts at B.

An ordinary compensated centrifugal governor is used to regulate the speed, acting by varying the pressure of the steam delivered to the turbine. By means of a by-pass in the main steam pipe it is possible to deliver steam of full pressure both to the entrance of the turbine and to a point in the machine nearer to the condenser, this enabling a higher power than the normal amount to be produced by the machine, much in the same manner as a compound engine may be used with full pressure steam in both high and low pressure cylinders.

forms a thin partial coating of aluminum on the copper. A thin sheet of aluminum is then laid on the prepared copper plate, the two are heated to about 800° C., and then passed through the rolls and rolled out into a thin sheet of copper having an aluminum plating on one side. By laying two such sheets, aluminum side down, on the two sides of a clean iron plate, and heating to about 400° C. in a muffle furnace, the sheets may be rolled together and a partial adhesion secured. The combined sheet is then heated to a higher heat, about

800° C., and rolled out to the desired thickness, a perfect adhesion being thereby secured between the iron and the copper by virtue of the layer of aluminum between them. Other combinations than this one are produced in the same general way; examples are copper-aluminum sheets, copper-aluminum-copper, steel (soft steel) coated with aluminum on one or both sides, or an aluminum core coated with steel, combinations of copper and zinc, of aluminum and zinc, or of all three metals, etc. The process is the invention of Mr. H. Wachwitz, of Nürnberg, and is being exploited by the German Wachwitz-metal Co., of Hersbruck, Germany.

THE PHENOMENON OF LIGHTNING.

From Paper, "Safeguards Against Lightning," read by Alfred Hands before the Fire Prevention Congress in London, July 6, 1903.

At the best, lightning is too often regarded as an electric current overcoming the resistance of the air; but this resistance has nothing in common with that which is the subject of Ohm's law, and to consider it merely as a momentary current is apt, I think, to give a somewhat misleading view of the matter. I want you to regard it as a breakdown of the dielectric—not as something leaving the sky to come to earth, or as being hurled from the clouds to strike a building, but to consider it—as indeed it is—as a fracture or cracking both of the air and of any other resisting medium between the oppositely charged bodies, the clouds and the earth. As a mechanical analogue, one may liken the air under these conditions to a thick slab of glass subjected to an enormous pressure from above and below, and which will crack when the pressure is greater than the material will bear. A building may be considered as a weaker object firmly embedded in the glass. We may, in fact, regard ourselves as living between the inner and outer coatings of an enormous Leyden jar or other condenser. Now, when the stress to which the air is subjected has reached the breaking point, which is about half a gramme weight per square centimeter (about 1-9 ounce per square inch), the line of the fracture becomes visible by the intense heat making the air particles momentarily incandescent, and this we call "lightning." The building which, being in the line of the strain, gets damaged, forms only a part of the fracture; the air is equally damaged, but is a self-repairing medium. Unfortunately, our buildings, trees and bodies, which are less resisting than the air, are not self-repairing, and so we get the deplorable losses of life and property that occur every year. A building offers less resistance than the surrounding air, therefore the breakdown would tend to go through a building rather than pass it by and go through the air beside it, even if there were no metals in it to render it still more weak. Even allowing for the effects of induction, lightning can no more be attracted by a conductor than a crack across a sheet of glass can be attracted by any weak part which would cause it to take other than a straight course.

DROP FORGING.

Proceedings of Engineers' Society of Western Pennsylvania, June, 1903, p. 292.

In a paper on drop forging read before the May 19 meeting of the Engineers' Society of Western Pennsylvania Mr. Dwight Goddard outlined the process of making drop forgings. That portion of the paper describing the dies is given in the following:

A set of dies consists of forging dies, outside trimming dies and, if there are any holes in the forging, inside trimming dies. The forging dies are the most important item. A pair of dies usually consists of two blocks of tool steel in which have been cut the shape to be forged. There are often two or more impressions in the same die block. On one side is an impression for breaking down or blocking out the metal, then a roughing impression that distributes the metal and approximates the shape and a finishing impression that brings the forging to exact shape and dimensions.

The shape and sequence of these impressions must be carefully considered to provide for a natural flowage of metal under hammering and to be such that the desired shape will be surely, quickly and economically formed. There must be no place short of metal, no overlapping and consequent "cold shuts" and no unnecessary blows or waste of stock. A draft of 5 to 7 degrees from the perpendicular must be allowed to permit a free release of the forging from the die. This is especially necessary if the section is such that an unusually quick chilling of the stock would cause the forging in shrinking to grip the die.

It requires a specially trained machinist known as a "die sinker" to make these dies. He must have experience and knowledge as to the action of metal under hammering, must have good judgment and high skill to enable him to plan, lay out and make the impressions. He must have a ready use of tools, both hand and machine, to reduce to a minimum, the cost of the labor in making, which will be high at best. The hand tools which he uses consist of a wide range of dividers, gages, shrink-rules, protractors, micrometers, riffers, chisels, files, and scrapers; the machine tools, die sinking machines, sensitive drills, milling machines, profilers, shapers, etc. In designing the dies, it is always best to procure, if possible, a model of the piece to be forged. Then a full sized drawing should be made showing the draft, the allowance for finish and any changes that seem necessary, to be submitted to the customer for his approval.

When the dies are about done, as far as shaping the impressions is concerned, they are clamped together and a lead cast made, as a proof of the shape. This is also sent to the customer for his approval. If satisfactory, the impressions are nicely finished to insure free release of the forging. The face of the die is cut away slightly for from ½ to 1 inch from the edges of the impression, to permit the free escape of the flash, or surplus metal. A groove is also made from one end of the impression to the outside to provide room for the sprue, which enables the forger to manipulate the forging by means of the bar from which the forgings are being made. Lastly the dies are carefully hardened and tempered that they may give the maximum service.

This is a very important operation and requires great skill in accomplishing. Even hardness of the face is essential, with no cracks or warping. By this time the dies represent great value, often hundreds of dollars. They should be capable of making from five to ten thousand forgings and the breaking of dies or the early wearing away of the edges may be a costly experience. The making of the dies is the expensive part of drop forging and forbids the making in small quantities.

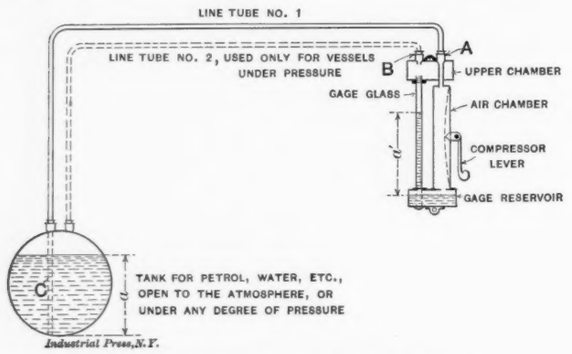
The customer is usually charged only a part of the cost of making the dies, and while they are kept strictly for his use he is not permitted to remove them. In such a case the drop forger is expected to keep the dies and tools in good order and to make such repairs as are necessary and to replace them when worn out, at his own expense. The reasons for this custom are obvious. Each drop forging company has developed from this experience special methods for the designing and construction of dies, which they do not care to place at the disposal of competing companies. They are also seeking to accumulate an amount of dies that will provide them their principal business which is forging, not die making. If a customer insists on owning the dies outright he is charged the full cost of making with a reasonable charge for this engineering experience, and is expected to keep his own dies in repair.

THE DEPTHOMETER; A DEVICE FOR MEASURING THE DEPTH OF LIQUIDS IN TANKS, ETC.

Daily Consular Report, No. 1772.

United States Consul Waterman at Dublin, Ireland, describes a depthometer invented by Mr. Leonard Murphy and manufactured by Daniel Miller & Co., Dublin. It is an instrument designed to show the depth of liquids either in open vessels—such as water tanks, vats, ship's holds, wells, etc.—or of liquids inclosed in vessels under any degree of pressure, as in the case of petrol tanks in some motor cars and other vessels of this kind. It may be placed at a distance from, and at any level relative to, the tanks—above, below, or on a level with them. Any number of tanks may be connected to one depthometer and the depth of each ascertained by indicating one at a time. The reading of the indicating column of the

depthometer is absolute, marking to a fraction of an inch the depth of the liquid being indicated. The reading can, of course, be reduced proportionately by using mercury or other heavy liquid for the indicating column. No floats or moving parts are used in the vessels being indicated, a fixed pipe of small bore being all that is required. The diagram shows the depthometer attached to a tank containing liquid. The instrument, shown in section, is placed somewhat above the tank and registers the exact depth of liquid in the tank by means of the column of liquid seen in the gage glass. When wishing to ascertain the depth of liquid in the vessel connected, it is merely necessary to raise the lever marked "compressor lever" and bring it back again to its starting point. On doing this the exact depth being measured will be shown by the column in the gage glass of the depthometer.



Device for measuring Depth of Liquid in a Tank.

The parts of the depthometer shown in the diagram are as follows: Two chambers, fixed one above the other, are connected by a gage glass tube, open at both ends, which reaches almost to the bottom of the lower chamber and only just enters the upper chamber from beneath. The top one is called the "upper chamber" and the lower chamber is called the "gage reservoir." The latter has attached to its top a flexible "air chamber" capable of being enlarged or reduced in volume by the compressor lever shown in the diagram. To the upper part of the air chamber a short tube and coupling, *A*, is attached, from which the line tube, No. 1, can be carried to the distant vessel, terminating in a dip pipe, *C*. If the vessel be under pressure a second line tube, No. 2, is necessary and is laid beside the first tube, reaching from the top of the tank to upper chamber, coupling at *B*, as shown in dotted lines on the diagram. This pipe is, however, not used if the vessel be open to the atmosphere, and in that case coupling *B* is left open to the air. The gage reservoir is next almost filled with the indicating fluid (petrol, water, etc.), and when at rest the liquid should just appear at the base of the visible portion of the gage glass. The instrument is then ready for use.

The method of working is as follows: Raise the compressor lever to its highest point, thus causing the air chamber to expand and take in a supply of air; the latter enters at coupling *B*, passes through the upper chamber, down the gage glass, through the liquid in the gage reservoir, and finally reaches the air chamber. On depressing the lever the air in this chamber becomes compressed and presses on the liquid in the gage reservoir. The air cannot, however, return through the gage glass, as the end of the latter is sealed by the indicating liquid. Some of the air, therefore, passes into the line tube No. 1, and on reaching the tank forces out any liquid which may have risen in the dip pipe, *C*, and ultimately the excess of air escapes from the open end of the dip pipe into the liquid in the tank. During this operation the liquid column in the gage glass of the depthometer will be seen to rise gradually to a certain point and then stand. The column ceases to rise further the moment the air commences to escape at the open end of the dip pipe in the tank, and the column thus shown will be equal in height to the depth of the liquid in the tank, as it will be seen that the air, having completely filled the line tube, has created an exact balance between the column of liquid in the tank and the indicating column of the depthometer.

CYLINDRICAL GRINDING.

Extract from paper read by Mr. C. H. Norton before the Cincinnati Metal Trades Association, October 8, 1903.

There is very little doubt that the first glimpses of cylindrical grinding came to all mechanics when using the lathe, and that these early dreams were tried here and there by mounting a small emery wheel on the tool-post of the lathe. Just where and when this was first done would be difficult to ascertain, but so far as we know the first really accurate grinding was done at Waltham, Mass., by the watch tool concerns about 1860. Mr. Webster, the father of the watch tool business, told me a few years before his death, the story of their earlier grinding. After using the lathe for some time with a small wheel in the toolpost they discovered that in order to grind tapers they should keep the centers in line; this they could not do with the lathe of that period, so they made what they called grinding lathes, that is, lathes with wheel carriage traveling on a slide that could be adjusted to an angle with the line of centers. This was some time about 1865. These were perhaps the first grinding machines with fixed centers and traversing wheel. They were rightly called "grinding lathes." They were small, the wheel being 4 inches diameter by ⅛ face on a spindle about ½ inch diameter. The swing of these lathes was about 6 inches and the largest work done did not exceed 1 inch diameter, while the greater amount was less than ½ inch diameter.

Some time about 1865, Mr. Brown, of J. R. Brown & Sharpe, at Providence, R. I., was grinding needle bars for sewing machines with what was called a "grinding lathe," arranged for the carriage to traverse and reverse automatically. This carried a wheel 6 inches diameter by ¼ inch face. The idea of constructing a machine designed especially for cylindrical grinding and to cut entirely loose from all traditions and features of the lathe, except, of course, the supporting center points, seems to have originated with Mr. Brown; for in the years following 1865 he gave the matter considerable study, and at his death in 1876 he had invented the "universal grinding machine," which was not a lathe but had a fixed wheel and traversing work.

When we realize that some 26 years ago cylindrical grinding machines were manufactured and sold by one of the best known concerns in the world, and that 40 years ago cylindrical grinding was done successfully in some of the best known shops of the day, we cannot but feel a little surprise that after all these years so important a factor in the economical production of good machinery should be strange to so large a proportion of machine builders, and that journeymen machinists, with exceptions so few that they are noticeable, have either neglected or refused to learn to use the grinding machine. At the same time there is no tool on our lists that is held in greater awe than the grinding machine.

Twenty years ago grinding was considered essential to really good work by concerns that now enjoy the best patronage of the entire world, and fifteen years ago they had reached the point where it was impossible to produce their work as cheaply without grinding as with it. The best grinding machines of to-day produce from four to six times more work than those of twelve years ago; and yet while large numbers of American machine builders are using modern grinding machines, there is a class who demand proofs in the way of tests, etc., before they can believe that grinding is practical for their work. The reason for this condition can be traced to the fact that while there are a large number of grinding machines in use, they are "universal grinders." In fact so familiar has the universal grinder become that it is very difficult for mechanics to understand that there are now in successful use cylindrical grinding machines that are not universal, and that they do not grind complicated or tool work. But they do grind all cylindrical work that is turned in lathes on two centers, and that, contrary to experience with universal grinders, they do remove considerable stock in an economical manner, saving many hours (on single pieces of work) that without their use would be expended in lathe work.

There is a common belief that it must consume more time to grind away stock than to turn it away. Therefore we find many insisting that to grind more than six or eight thou-

sandths from the diameter of cylindrical work must be an expense, and in fact to grind at all must cost more than to turn to size in the lathe. This belief has been strengthened by the fact that grinding machines in the past have been made as producers of accurate work only, with no thought as to the possibilities of reducing diameters economically.

Within the last three years there have been great changes in the design of machines and in the methods of handling work, as well as great improvements in grinding wheels. So great have been these changes and so really wonderful have been the results, that no manager can afford to judge by any experience gained by the use of machines of the older designs in the hands of operators trained under the older methods using wheels of older selection.

SPEEDS AND FEEDS.

From paper read before Cincinnati Metal Trades Association, by Frederick Holz, President Cincinnati Milling Machine Co.

We may listen with wonder to-day to one of our friends who is running a surface cutting speed of 100 feet per minute, and feel that this is the limit, only to learn to-morrow that our neighbor applies a speed of 150 feet per minute, and thus the increase in speeds goes on. To-day the speed barometer stands at 250 feet in one of our Cincinnati shops.

It is also true that while we read a great deal of fast feeds and speeds we see very little of them when going through the country visiting shops, for these things are in a very experimental stage. Most of our present machine tools are not satisfactory for high-speed tool steel. Whenever we undertake to use the new steel, we meet with all sorts of breakdowns and other difficulties.

We have often noticed on forged spindles and similar work, evidence of very coarse feeds used on the rough turned part as they come from the forge shop, and Mr. Lodge and I went to Pittsburg to see the methods by which these are made. At one of the Carnegie shops near Homestead, we witnessed an axle lathe taking a heavy cut ¼ inch deep on a 5-inch diameter axle as it came from the forge. The carriage on this lathe traveled 3⅜ inches a minute. This was done with a single, tool, Crescent self-hardening.

Later we took a trip through some of the large shops in the Great Lakes district and in Milwaukee. We were told of a speed which broke all records we had ever heard of. Mr. Schoeltke, superintendent of the Nordberg Mfg. Co. told us that he turned a 5¼-inch diameter shaft, reducing it to 5 inches, 22 inches long, in one minute. Very much to our disappointment, we could not see the actual performance, but we were shown the data and records of the test.

Upon returning I had a 24-inch lathe rigged up with a 5 horse power motor, which we supposed would have ample power. We commenced our experiments on a 4¾-inch diameter machinery steel shaft, such as we use for overarms on our milling machines, and it worked well. We got carriage travel on this job of 17 inches in one minute, taking a cut ⅛ inch deep. We could see that this was not the limit, but had already consumed 10 horse power for this one lathe and that was all the motor could stand. We had two Novo tools—one in front and one in back—and used the leadscrew for feeding, and geared it up same as for cutting 5 threads to the inch. Since that time we have arranged for a 12 horse power motor. I only mention this experiment to point out what we may have to look for in the near future as to power. Of course, this 4¾-inch shaft had all the advantages in its favor. It was short in comparison with its diameter and quite stiff. Two tools were used to counterbalance the strain. The material was uniform. Records like these cannot be made in every-day practice, but experiments of this kind have a good effect, in that they help to make things "speed up" all around in the whole establishment.

We are not altogether through with this experiment yet. I feel that by the time we get to the end the same shafts will be turned at the rate of 24" a minute. On planer work we run light roughing cuts ⅛ inch deep, 70 and 80 feet per minute on cast iron, provided the material is fair. We use variable speed countershaft, which is absolutely necessary on planers, since finishing cuts are run at the rate of 18 to 20 feet per minute on the same planer.

In milling machine practice it is very seldom a cutter is injured by a feed unless it is abused. It is an old and mistaken idea that a cutter must be fed slowly in order to preserve it. If we analyze this subject we will find that the chip per tooth of a milling cutter is very small in comparison with the chip of a lathe or planer tool, and it is better for the cutter to give it a fast feed instead of a slow one. It is certainly better for any tool to cut into the surface instead of simply rubbing over it, and the more positive and steady this feed is, the better it is for the cutter. This argument especially holds good for roughing out work. For finishing, a high speed may be applied and a finer feed used, with finer teeth in the cutter. For roughing cuts, cutters with very coarse teeth to allow room for the chips, should be used. On ordinary class of work the medium coarse-tooth cutter answers for both the roughing and finishing.

Example 1.—Material, .90 carbon tool steel; width of surface, 5 inches; depth of cut, 1-32 to 3-64 inch; cutter, 3 inches diameter; 56 revolutions per minute; table feed, 2.8 inches per minute. This is a severe test, but the No. 2 plain miller does the work right along without chatter, with limit of accuracy of .001 inch.

Example 2.—Cast-iron bar, 1 inch thick, in which a slot is milled 22 inches long; Novo steel end mill, working at surface speed of 66 feet; table travel, 4 inches per minute.

Example 3.—Roughing the top of vise housings for a milling machine; Ingersoll type cutter used, 4½ inches diameter, at cutting speed of 40 feet per minute; feed, 8½ inches per minute; depth of cut, 3-32 to ⅛ inch.

[Several other illustrations were given, of pieces milled with formed cutters, or having several operations, with more than one cutter, which cannot well be summarized.—EDITOR.]

STEAM TURBINES COMPARED.

From paper by A. R. Dodge, read before N. E. Cotton Mfrs. Assoc. (Mr. Dodge represents the Curtis Turbine.)

One of the earliest efficient turbines of practical form was brought out by De Laval, and consists of a single combination of nozzles and a wheel attached to the shaft, carrying the vanes on its periphery.

The transformation of pressure into velocity in the nozzle is complex, but highly efficient. The steam at the area of smallest cross section, called the throat, always has a pressure about 58 per cent. of the initial and a velocity of 1,500 feet per second, unless reduced by a higher back pressure, at

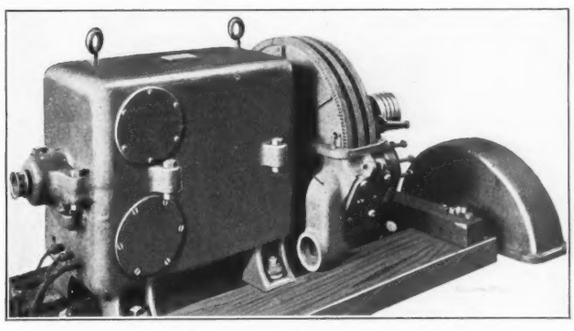


Fig. 1. Small Curtis Turbine and Generator for Train Lighting.

the discharge end of the nozzle. If a greater velocity is desired, the cross section at the throat is not changed, but the area of nozzle discharge is increased. We have, therefore, a means of obtaining any desired velocity entering the vanes by throttling the nozzle-end pressure, if less than 1,500 feet is desired, and by nozzle expansion if a greater velocity is essential. With this type a high velocity of the moving vanes is essential.

An initial pressure of 150 pounds will give a jet velocity of about 4,000 feet per second, if expanded to 28 inches vacuum. The vanes must therefore rotate at a speed of about 2,000 feet per second to abstract the maximum energy, a speed limited by the strength of material. About 1,200 feet per second is realized in practice, therefore this type is better adapted for a smaller range between initial and final pres-

sures. A peripheral speed of 1,200 feet per second with this form of wheel necessitates the use of a flexible shaft and special gearing.

The Parsons machine was brought out shortly before the De Laval, and has much lower velocities of steam and vanes, and the process of transforming pressure into work must be repeated many times, entailing a large number of successive revolving rows of vanes with stationary rows of vanes between each. As there is considerable drop in steam pressure between the entering and discharging sides of the revolving vanes, owing to small clearances, an unbalanced pressure acts on the vanes. This results in a serious end thrust, which is reduced by making the drum carrying the vanes of small diameter, thereby increasing the revolutions per minute and the difficulties of generator design, as gearing is not used.

Many of the vanes must therefore rotate in steam of high density, and there is considerable brake action between vanes and outer shell due to water of condensation. Both of these losses are reduced by superheat. The large number of vanes, about 31,000 in a 300-kilowatt set, are inserted by hand, and the longer ones held at the outer end by supporting wires, to which the vanes are soldered.

The Rateau type is similar to the De Laval, except that the combination of nozzles and single wheel is repeated several times, with less expansion during each process than in the earlier turbines. A space is given for the steam discharged

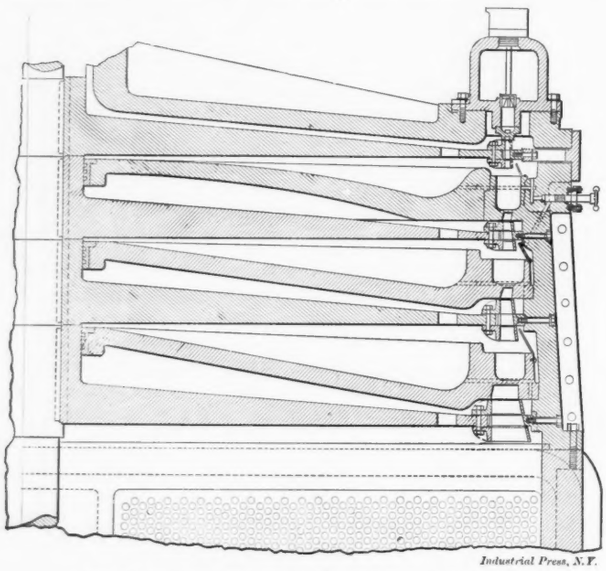


Fig. 2. Sectional Elevation of one-half of Curtis Turbine.

from the revolving vanes to utilize its energy in the form of velocity by evaporating part of the moisture, and start the process of fractional abstraction anew in the following nozzle. A single wheel per nozzle, or group of nozzles affords a minimum change in the direction of the steam jet at high velocity and shortens its opportunity to diverge, before a following nozzle again brings it into line.

The outer clearance is small and the buckets have no outer band like the De Laval, but as steam is admitted only in sections of the periphery, end thrust is eliminated as the pressure on each side of the disk tends to equalize through the empty vanes.

The cylindrical clearance space between each intermediate nozzle and revolving element is near the shaft where the clearance can be made a minimum. This greatly increases the area of stationary nozzle surface near the revolving elements and adds to the loss through friction. As in the Parsons type, many of the wheels revolve in steam of high density and the friction caused by water of condensation is considerable. A print of this turbine, recently published, shows twenty-five wheels and twenty-five sets of directing nozzles. Proper adjustment of these twenty-five clearances with variable shaft temperatures, leaves much to be desired as to simplicity.

Still another type is that brought out in this country by Mr. Curtis, which in addition to nozzles delivering steam at high velocity to a single wheel has also stationary vanes which redirect the steam discharged at considerable velocity from the first wheel, due to the relatively low bucket speed, into the second wheel. The velocity of the jet leaving the nozzle is about 2,000 feet per second, about half the velocity of the De Laval under the same conditions of exhaust pressure, while the peripheral speed of the vanes in the Curtis is proportionally much less, about 400 feet per second, instead of 1,200 feet per second. By this process of fractional abstraction the speed of revolving vanes need not be excessive to secure maximum economy, in other words to bring the direction of the jet discharged from the last set of vanes parallel to the shaft. With this high-steam velocity comparatively few revolving vanes are necessary, and they rotate in steam which has a lower density, due to the considerable drop in pressure from one stage to the next. There is a large clearance between outer wall of revolving vanes and the shell, reducing friction due to water of condensation. End thrust is eliminated, as there is abundant opportunity for the pressure to equalize on each side of the revolving disks, and the entrance and discharge angles of the vanes are the same.

A still more recent type, the Stumpf turbine, has a single rotating element with buckets cut in the solid disk, which is made of nickel-steel, and operates with a rim velocity of 1,200 feet per second, and a low shaft speed, reduced by the large diameter of the disk. The centrifugal forces are very high, but a factor of safety of five is guaranteed.

The vanes are cut similar to those of the Pelton water wheel and the jet is directed against the wheel in much the same way. The wheel is sufficiently wide to allow two rows of vanes. Steam enters one of these sets of vanes, which abstracts a fraction of the velocity, flowing in the direction of the shaft to the edge of the wheel, and is then carried over to enter the vanes on the other side of the wheel by a stationary vane.

The following table embodying approximately the velocities of turbines of 300 kilowatts to 500 kilowatts capacity will aid in this comparison:

	Rows of Rotating Bucket Rings.	Steam Velocity feet per second.	R. P. M	Peripheral Speed	Buckets.
Parsons.....	35	400	3,600	200	inserted
Rateau.....	25	800	2,400	400	inserted
Curtis.....	8	2,000	1,800	400	solid
Stumpf.....	1	4,000	3,000	1,200	solid
De Laval.....	1	4,000	20,000	1,200	inserted

Each type has its characteristics and the advantages of one over another will depend largely on the cost of construction, reliability, and improvement in efficiency.

* * *

A correspondent of the *Railroad Gazette* suggests a solution of the alleged vexing confusion in the use of the word "engineer" in this country. In England and on the Continent, the term "engineer" means a member of a learned profession; here it means both the learned gentleman and the greasy "gent" who pulls the throttle of a steam engine, which, of course, is supposed to materially detract from the dignity of the aforesaid gentleman. In England a locomotive "engineer" is a "driver" and a stationary throttle-puller is an "engineman" or "machinist." Mr. Szlapka would substitute the word "ingeneer" for "engineer" when it is applied to the professional man, thus: *Henry Szlapka, Consulting Ingeneer.*

* * *

The moving picture machine is now being used not only for the purpose of amusement, but for business as well. An instance is that of a new car fender that is being exploited by the aid of a portable mutoscope, which the salesman can carry about with him to capture the attention of the busy street railway manager, and at the same time make an impression that otherwise would be quite impossible. The views show a practical test of the fender on a living subject, the fender picking him up without injury when running at a speed of about 22 miles per hour. The views, taken in Brooklyn, show the car rapidly approaching the victim, the "accident," his position in the fender and final rescue uninjured. The scheme for selling the appliance is not less wonderful than the device itself.

CUTTING FRACTIONAL SCREW THREADS.

FRED H. COLVIN.

Thread cutting is always an interesting problem and the question of change gears is one that comes up every day in the shop. The gear tables show what to use for a regular thread but when it comes to fractional threads many are all at sea. Then they want a book or a table that will show just what they wish to know without any figuring. But they forget that there is almost no uniformity of practice among lathe builders and that leadscrews vary, as well as the "jumps" between change gears; some go by 4 teeth, some by 5, etc. Then, too, there are ways of "doubling up" in the head, by putting in a compound or back gear out of sight in the headstock.

The first thing to do in any case is to find out the exact ratio between the spindle and the leadscrew, which might be called the "constant" for the lathe. This could be defined as the ratio between the gears required to move the carriage one inch for every revolution of the spindle. It might be suggested that this could be the ratio between the gears which would cut the same thread as the leadscrew, but for fractional threads the former is the better and will cause less confusion. If there are no multiplying gears (which would be equivalent to putting the first gear on the lathe spindle) the teeth in the spindle or first gear will be as many times those of the leadscrew gear as the leadscrew has threads per inch. Thus, with a 6-pitch leadscrew the screw must turn 6 times to move the carriage an inch. But as is often the case, it may be found that with even, or similar gears, the lathe would cut a 3-pitch, or only require 3 turns of the leadscrew to move the carriage an inch. This shows there is a multiplying gear in the head, such as a 48 on the spindle, driving a 24 on the stud which takes the first change gear.

For practical use, find the equivalent pitch of leadscrew by putting even gears on both stud and screw, and find what thread would be cut. It may be that a 48 gear on spindle drives a 32 on the stud, when the screw will be equivalent to a 4 instead of a 6. Then to cut a 12-pitch thread multiply both 4 and 12 by any number that will give gears upon the gear list. Multiplying by 5 gives 20 and 60. If these gears are not at hand, try multiplying by 4½, which gives 18 and 54. To cut 11½, multiply by 8, giving 32 and 92. Probably there will not be any 92 gear so a 46 may be used on the screw and a 2 to 1 multiplying gear put on the compound stud. If these gears cannot be had, try some multiplier which will give gears that are in stock. 4 times 4 = 16 and 4 × 11½ = 46, so that a 16 will do, but it is smaller than is usually found. Six gives 24 and 69 and the latter is an odd gear but may be supplied for cutting this thread.

For cutting threads expressed in pitch to the inch this is the easiest way, but for pitches expressed in inches it is apt to be confusing, and for this reason it is better to consider the leadscrew in inches rather than threads per inch. A 4 pitch leadscrew would then be ¼ — a 2 pitch ½ etc., always remembering that the leadscrew is considered at its equivalent pitch, or the distance it moves the carriage for one revolution of the lathe spindle. Taking the leadscrew as ¼ inch pitch and having to cut a screw which measures ¾ inch from thread to thread we readily see that the leadscrew must make 3 turns to one of the spindle. Consequently the gear on the stud must have 3 times as many teeth as the gear on the screw. Putting this in example form we say: ¼ is to ¾, as the gears that we are to use. The ¼ is the leadscrew gear and ¾ the stud gear. As they both have the same figure below the line (denominator) we only consider the figures above, which are 1 and 3. Multiplying both by 20 we have 20 and 60; or by 24, we get 24 and 72. Either of these gears paired as shown will cut the thread.

Still keeping the ¼-inch pitch leadscrew—and we will keep this during all the calculations—we have a piece of work requiring a thread with a 13-16-inch pitch, or ¾ and 1-16 as some say. Now, while this looks like a puzzler, it is easy if we keep cool and do a little thinking. As the pitch desired is in 16ths of an inch, reduce the leadscrew pitch to same terms and ¼ = 4-16. Then we can neglect the denominators and only consider 13 and 4. As the desired pitch is faster than the leadscrew, the leadscrew must be turned faster than the spindle, so the large gear goes on the stud. Multiply 13 and 4 by any number that will give gears that are in stock. Multiplying by 4 gives 52 and 16, by 5 gives 65 and 20, and by 6 gives 78 and 24, any of which will answer the purpose.

Another puzzle is when the foreman calls for a thread making one turn in an inch and seven-sixteenths, or 1 7-16 pitch. As we usually think of a thread as being less than an inch pitch this might easily puzzle one who isn't used to it. But we simply reduce the fraction to 16 + 7 = 23-16 and the leadscrew to 4-16 and then forget the 16s entirely, so this is 23 and 4. Multiplying by 6 gives 138 and 24. But 138 is larger than most lathes possess, so we must compound. A 2 to 1 compound would give 69 for the large gear. Many lathes would not have this gear, so if we can compound 3 to 1, divide 138 by 3 and get 46 for the large gear.

Still another way to get stuck is to have the pitch given as ¾ of a turn to the inch. This isn't ¾-inch pitch but a pitch faster than one per inch. As there must be 4-4 to the thread and only 3 of these take place in one inch it is clear that ¼ of the pitch must take 1-3 of an inch so that the whole pitch must be 1 1-3 or 4-3 inch. With the same leadscrew of ¼-inch pitch we must reduce the fractions to the common denominator which will be 12. Then 4-3 = 16-12 and ¼ = 3-12 so we have a ratio of 16 to 3. Multiplying by 6 gives 96 and 18 as gears that will cut this. One more example of this kind may help. Call this 7-16 of a turn to the inch. As there are 9-16 more to the thread it must move 1 2-7 inches for the balance. This makes the pitch 2 2-7 inches or 16-7. Then with leadscrew ¼ we must reduce them to same fraction. The lowest common denominator is 28 and this gives 64-28 and 7-24 or 64 to 7, a large ratio. Multiplying by 4 gives 256 and 28 which will probably require compounding at 4 to 1 if it can be done. This would give 64 to 28 as the right gears.

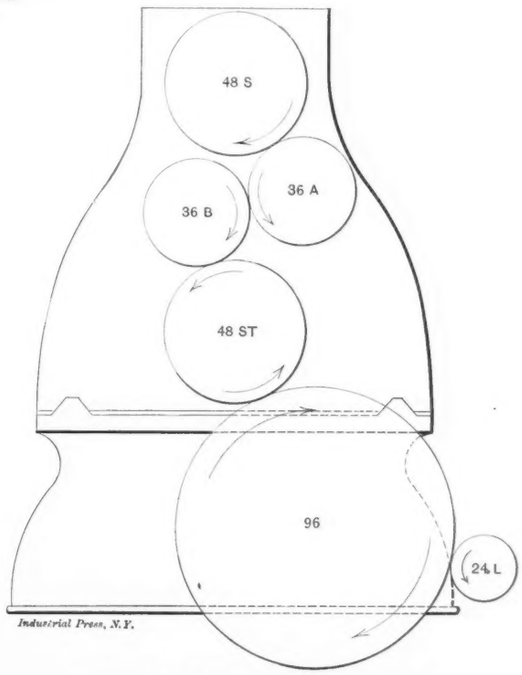


Diagram of End of Lathe, showing Gearing.

Fractional pitches are not nearly as hard as they look if one goes at them slowly and follows directions. To make this more complete and satisfy those who want tables, the writer has calculated the two tables which follow. But before giving them it is necessary, or at least desirable to go to the root of thread cutting, so that they will not be wrongly used and then blamed for mistakes which may be made. To help make this clearer the end of the lathe with its gears is shown in outline. This is only one of many arrangements but it will serve the purpose. The lathe spindle has a 48 toothed gear which drives one of the two smaller gears shown. The arrows show direction. The 48 toothed gear below carries the stud on which the change gears are placed, but to avoid con-

fusion, the large intermediate gear is shown driven directly by the 48 tooth gear. The leadscrew carries a 24 tooth gear, as shown.

This is a good place to emphasize the fact that the only gears that need be counted in a simple train are the driver and the driven, or the first and the last. The intermediate gears do not count *unless compounded*, but this will be explained later.

First consider the lathe head only or the gears from the spindle to the stud, including both. The spindle carries a 48 gear. In one revolution this will drive the next gear 48 teeth. No matter about revolutions now—these don't count till we come to the driven gear—the last of the train. Each gear moves 48 teeth every time the driver makes one revolution and as the gear on the stud—the last of this train—has 48 teeth it moves 1 revolution. In other words, they are "geared even." The intermediate gears marked 36A and 36B are merely for reversing the direction of the leadscrew or for cutting it out altogether. The gears move so that both *A* and *B* can be out of mesh with the spindle or that *B* drives. In this case gear *A* simply runs idle. If the gear driving the stud *ST* had 96 teeth it would turn half as fast as the

EQUIVALENT OR TRUE PITCH OF LEADSCREW.

Pitch in inches.	2	3	4	5	6
	S. L. S.	S. L. S.	S. L. S	S. L. S	S. L. S.
5/16 inch.	20 — 32	30 — 32	30 — 24	50 — 32	60 — 32
	25 — 40	75 — 80	25 — 20	125 — 80	75 — 40
8/8 "	24 — 32	36 — 32	36 — 24	60 — 32	54 — 24
	30 — 40	45 — 40	30 — 20	75 — 40	45 — 20
7/16 "	28 — 32	42 — 32	42 — 24	70 — 32	84 — 32
	35 — 40	105 — 80	35 — 20	175 — 80	105 — 40
1/2 "	24 — 24	36 — 24	48 — 24	80 — 32	72 — 24
	25 — 25	30 — 20	40 — 20	60 — 24	60 — 20
9/16 "	36 — 32	54 — 32	54 — 24	90 — 32	108 — 32
	45 — 40	125 — 80	45 — 20	225 — 80	135 — 40
5/8 "	30 — 24	60 — 32	60 — 24	100 — 32	90 — 24
	25 — 20	75 — 40	50 — 20	125 — 40	75 — 20
11/16 "	44 — 32	66 — 32	66 — 24	110 — 32	132 — 32
	55 — 40	165 — 80	55 — 20	275 — 80	165 — 40
8/4 "	36 — 24	72 — 32	72 — 24	120 — 32	108 — 24
	30 — 20	45 — 20	60 — 20	90 — 24	90 — 20
13/16 "	52 — 32	78 — 32	78 — 24	130 — 32	156 — 32
	65 — 40	195 — 80	65 — 20	325 — 80	117 — 24
7/8 "	56 — 32	84 — 32	84 — 24	140 — 32	126 — 24
	35 — 20	105 — 40	70 — 20	105 — 24	105 — 20
15/16 "	60 — 32	90 — 32	90 — 24	150 — 32	180 — 32
	75 — 40	255 — 80	75 — 20	375 — 80	225 — 40
1 1/16 "	68 — 32	102 — 32	136 — 32	.....	.....
	85 — 40	225 — 80	85 — 20	.....	.....
1 1/8 "	72 — 32	108 — 32	108 — 24	.....	.....
	45 — 20	135 — 40	90 — 20	.....	.....
1 3/16 "	76 — 32	114 — 32	104 — 24	.....	.....
	95 — 40	.....	95 — 20	.....	.....

Table No. 1.

spindle and make it necessary to consider the leadscrew half the actual pitch. This is the "true" or "equivalent" pitch considered in the tables. This is sometimes done in building lathes and, as will be seen, confuses anyone who attempts to figure gears with an iron-clad rule and doesn't look at the ratios of the spindle, stud and leadscrew. Returning to the cut and calling the stud 48, we realize that this will drive the large gear 48 teeth (no matter what part of a revolution) and in turn drives the last gear the same number of teeth. As this last gear has 24 teeth, it will make two revolutions, and cut a thread double that of the leadscrew.

If now, instead of running the large gear in mesh with the 48 *ST* gear, we put a 24 gear beside it, and drive the large gear from that, we have compounded the gears. While *ST* moves 48 teeth, the large gear is only driven 24 and the leadscrew makes one revolution. If on the other hand, we put a 96 on beside the *ST* gear, we will compound the other way and drive the leadscrew four revolutions to one of the spindle.

It is sometimes difficult to see the gears in the head but it is easy to put "even" gears on both stud and leadscrew and see what thread is cut. This is the true leadscrew pitch and should be used in all calculations rather than the actual pitch. In the tables that follow, gears have been used that are usually found on lathes, although in some cases it has not been possible to do so. Two combinations are given in most cases, one using gears which vary by 2 or 4 teeth and the other by 5 teeth. Where very large gears are called for, it will usually be found necessary to compound between the stud and leadscrew. Take, for example, the pitch of 1 1-16 inch with a 4 pitch leadscrew. The gears are 136-32. If now we compound so as to double the speed of the leadscrew, it becomes equivalent to a 2 pitch and a 68 gear on the stud does the same work. The tables are accurate if used as intended—but care must be taken to avoid mistakes.

EQUIVALENT OR TRUE PITCH OF LEADSCREW.

Threads to inch.	2	3	4	5	6
	S. L. S	S L S.	S. L S.	S L. S.	S. L. S.
11½	24 — 138	24 — 92	32 — 92	20 — 46	24 — 46
	20 — 115	30 — 115	40 — 115	50 — 115	60 — 115
5½	24 — 66	24 — 44	32 — 44	20 — 22	24 — 22
	20 — 55	30 — 55	40 — 55	50 — 55	60 — 55
4½	24 — 54	24 — 36	32 — 36	40 — 36	48 — 36
	20 — 45	30 — 45	40 — 45	50 — 45	60 — 45
3½	24 — 42	24 — 28	32 — 28	40 — 28	48 — 28
	20 — 35	30 — 35	40 — 35	50 — 35	60 — 35
2½	24 — 30	24 — 20	32 — 20	40 — 20	48 — 20
	20 — 25	30 — 25	40 — 25	50 — 25	60 — 25
1½	32 — 24	48 — 24	64 — 24	80 — 24	96 — 24
	40 — 30	60 — 30	80 — 30	100 — 30	100 — 25

Table No. 2.

The tables do not by any means show *all* the gear combinations that will cut given threads, only two of the combinations most likely to be found. No gear below 20 is used. As an example of what might be done take 7-16 inch pitch and leadscrew of 2 pitch. This reduced to inches gives 7-16 and ½ inch or 7-16 and 8-16 or a ratio of 7 to 8, the 7 for the stud and 8 for the leadscrew. Multiply both of these by any number and get any gears that can be used, such as:

S.	L. S.	S.	L S.
21	24	49	56
28	32	56	64
35	40	63	72
42	48	70	80

And by compounding, a much larger variety may be obtained.

Just remember that the whole question is simply the number of revolutions of the leadscrew as compared with the spindle, or the distance the carriage will be moved by one turn of the spindle, and no trouble will be experienced.

* * *

MOLDING WITHOUT PATTERNS.

An interesting article by Mr. Henry Hess on floor molding without patterns, appeared in the October issue of the *Foundry*, which is based on the writer's experience while connected with the German Niles Tool Works at Berlin, Germany. The article illustrates how floorplates, lathe beds, large faceplates, etc., were molded without the use of patterns. Of course dry sand cores play a leading part in such work, units being joined together to form the complete mold in much the same manner as has been practiced for several years in the country in the casting of medium heavy flywheels. Molding flywheels in this fashion as practised by Jones & Laughlins, Pittsburg, Pa.; Struthers, Wells & Co., Warren, Pa.; Geo. V. Cresson Co., Philadelphia, Pa., and others, requires a pattern of one section only, by which is meant one spoke and such a portion of the arc of the hub and rim as is expressed by 360 degrees divided by the number of spokes. Dry sand "cores" are made from the pattern, and when assembled, of course, inclose a cavity of its shape. If there are eight spokes in the wheel, the complete mold will consist of eight of these cores arranged in a circle, thus forming a complete hub and rim. Jones & Laughlins have a large flywheel cast in one piece by this process, which has been running for a number of years at a peripheral speed of nearly two miles a minute.

* * *

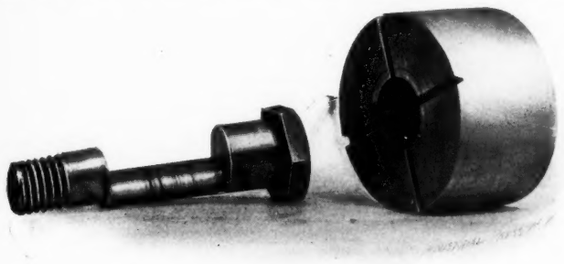
A subscriber is building a special machine in which it is necessary to have certain iron parts covered with canvas and wishes the receipt for a cement which will stick the canvas securely to the iron. If any readers have had experience with such a cement we should be glad to receive directions for making it.

LETTERS UPON PRACTICAL SUBJECTS.

A SLIGHTLY (?) WORN ROLLER PIN.

Editor MACHINERY:

The accompanying cut shows a cam roller and pin as they were recently removed from a machine in which they had been in use for about eight months. They had been causing trouble for some time and an examination by the master mechanic revealed the condition of affairs here shown. It was found that the rollers had been made from tool steel and hardened, while the pins were of machinery steel which was not hardened. As will be seen in the photograph, a series of grooves have been cut by the workman in each end of the roller for the purpose of admitting oil to the pin. This had



Cam Roller and Worn Pin.

the effect of causing the roller to act as a milling cutter and the pin was cut smooth and true on each side of the portion that was worn down. As the chips had no way of escape, the roller being held in a forked lever, they were carried in with the oil and helped to grind the pin down, thus throwing the machine out of order.

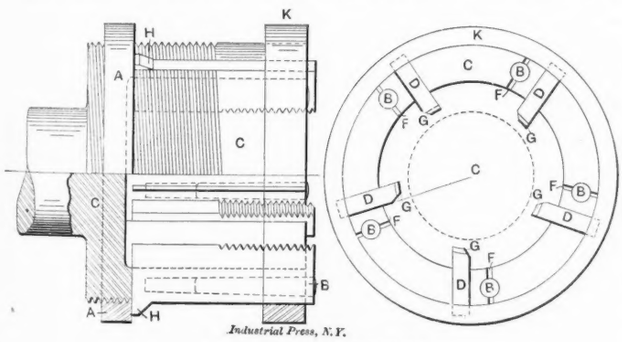
Two lessons may be learned from this experience: First, to follow the specifications given on the drawing, which in this case called for both pieces to be made of tool steel and hardened; second, not to cut oil grooves in the ends of a roller.

Port Chester, N. Y. A. D. FINLEY.

A LARGE DIE FOR CAST IRON.

Editor MACHINERY:

The accompanying sketch shows a die, made by the writer, which has been used with considerable success for threading large cast-iron work. *C* is a collet which holds the dies *DD*. A short distance in front of the slots in which the dies fit, are a series of smaller slots, *FF*, in the center of which are placed taper pins, *BB*. When the dies have been put in place these pins are driven in firmly and, expanding the slot, they cause the die to be held tightly in position. A ring, *K*,



Die for Large Cast Iron Work.

is placed around the outside of the collet to prevent the dies from spreading out. On the back end of the collet is screwed a ring, *A*, and the ends of the dies, terminating in the shoulders, *H*, bear against this ring. As the die becomes dull the ring is screwed further on and the blades are thereby pushed forward so that their front ends may be ground off until a sharp thread is reached. In this way the blades can be used for almost their entire length and, when completely worn out, it is a comparatively simple matter to supply the holder with a new set of cutters.

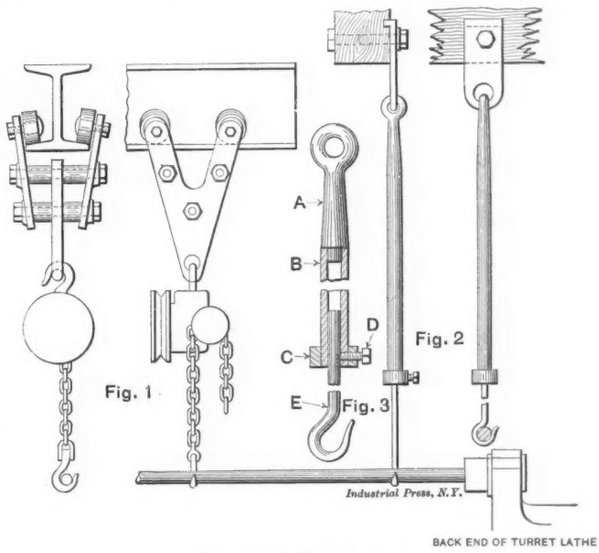
It will be seen in the sketch that the front side of the die is in line with the center of *C*. When the dies were first made they would not work at all, but when the corners had been ground off, as at *G*, they worked very well except on some castings which seemed to be of unusually difficult iron to cut. I would like the opinion of some of the readers of MACHINERY as to whether I have followed the right course in constructing the die in this way, or should the cutters have been set forward of the center? Dies of this class may be profitably employed quite frequently, and if any one can suggest an improvement, or point out any error in regard to the position of the cutters, the information will, without doubt, be of interest to others as well as to the writer.

Cedar Rapids, Iowa. M. E. SANDERS.

ADJUSTABLE HANGERS AND SUPPORTS FOR USE WITH TURRET LATHES.

Editor MACHINERY:

Almost any one who has had much to do with the handling of bar stock on the screw machine or the turret lathe, is familiar with the troubles common to the forked support or rest generally used, and cannot fail to realize the heavy strain imposed upon a man when using large stock; to say nothing of the noise and rattle that accompany the revolution of a 2-inch iron or steel bar, 16 feet long, when the rest is a



Stock Supports and Hangers.

little too high or too low. Additional strain is also put upon the man when he is, every now and then, required to move the heavy standard to accommodate the length of the bar.

Figs. 1 and 2 show two types of stock carriers that will be found to greatly lessen this trouble and incidentally save considerable time owing to the ease and quickness with which stock can be handled with their aid. Fig. 1 shows a chain hoist attached to a small traveling carriage which moves upon the lower flange of an I-beam that is fastened to the floor timbers above the machine. Fig. 2 shows an adjustable support that is fastened to a beam just above the end of the lathe. This same style of support may also be attached to the traveling carriage in place of the chain hoist. With a traveling support of this kind, one man alone can readily take a bar of the largest stock from the rack, run it up to the machine, slip one end through the fixed support and place the bar in the machine. The chain hoist, however, will be found most convenient as it enables the operator to easily lift the stock from the floor.

The construction of the adjustable hanger is shown in Fig. 3. On the end of eye, *A*, is forged a piece of wrought iron pipe, *B*, of any length required to suit the height of the beam above the machine. A collar, *C*, is shrunk onto the lower end of this pipe and through it is passed the setscrew, *D*, which

holds the hook at any desired height. The hook, *E*, slips up inside of the pipe and if marks be made upon it where it enters the pipe, it can be readily adjusted in height to suit any size of stock.

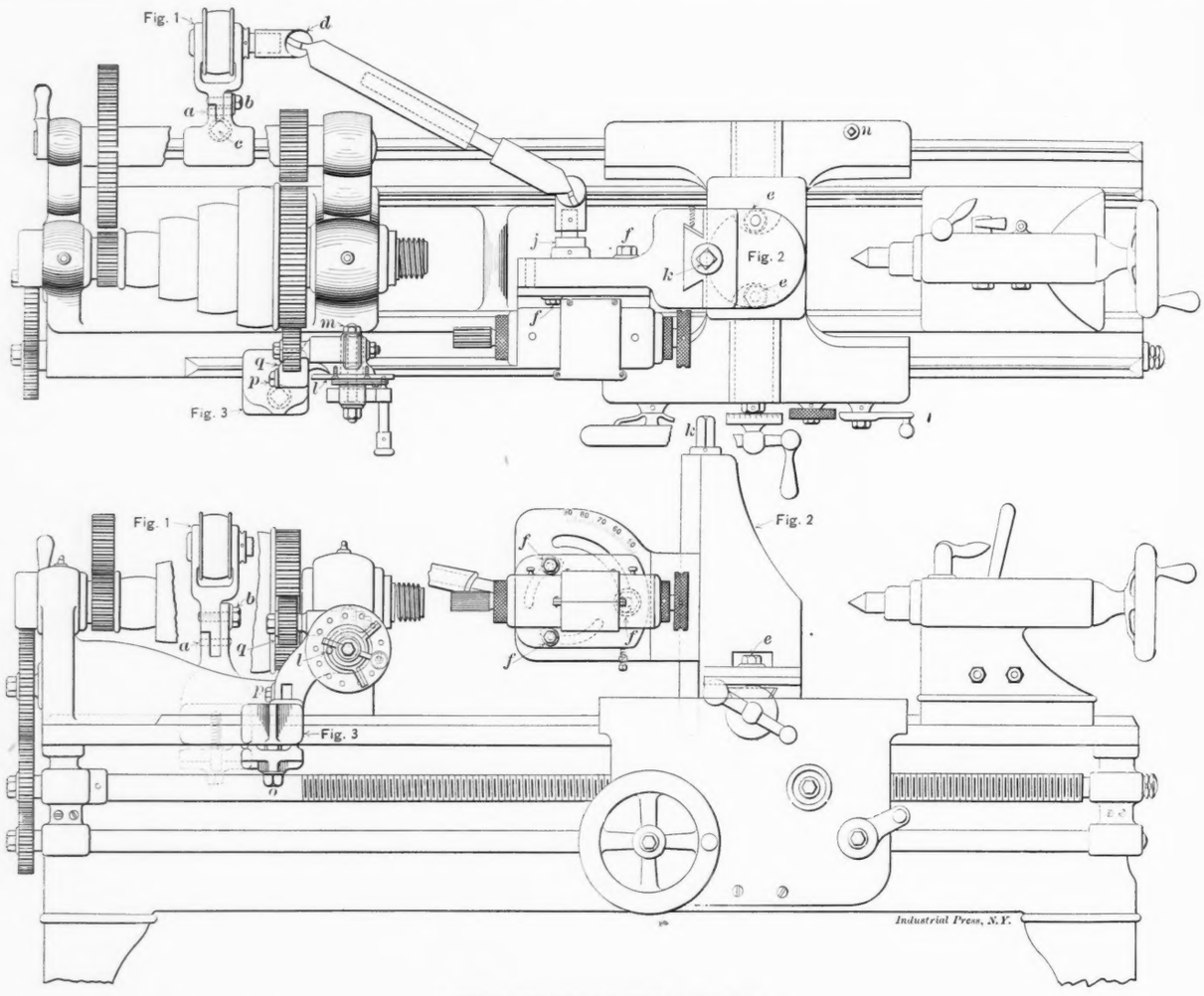
A convenient arrangement, where stock is to be supplied to several machines, is to furnish each machine with one stationary, adjustable support and one adjustable support on a traveling carriage, then one carriage with chain hoist can be used to bring stock up to any of the machines desired, and as soon as it has been placed in the supports belonging to that particular machine, the hoist may be removed and used elsewhere.

C. NEIL.

A MILLING ATTACHMENT FOR THE LATHE.

Editor MACHINERY:

It frequently happens that it is desired to take a milling cut on a piece of work while it is still held upon the faceplate of the lathe upon which it has been turned. In order to do this the attachment illustrated in the drawing herewith will be found very convenient. While the arrangement here shown may be still further improved, this one has already proved very satisfactory for any kind of work that has been attempted upon it. With the three attachments in position as shown, all that is necessary for the operator to do is to attend to the indexing of the work around to its lines of measurements. These attachments are especially useful for milling circles, circular slots, etc., in plain or irregular pieces. When in use they are bolted securely to the lathe and can be adjusted to any desired position. One point of advantage that will be noticed in connection with these attachments is that it is unnecessary to change the construction of the lathe in any respect, as they require no holes or other alterations that would in any way impair the efficiency of the lathe. They are quickly attached and easily adjusted, and as they are driven from the lathe itself no extra countershaft is required.



A Milling Attachment Applied to the Lathe.

The milling spindle is driven through bevel gears which are connected by telescopic rod and universal joints to the driving attachment shown at Fig. 1. The driving attachment is operated by a belt which runs over any step of the lathe cone that is calculated to give the required cutting speed to the milling cutter. When the milling attachment is being used the cone locking bolt is thrown out so that the cone runs free on the lathe spindle, and as the cone may be driven on any step and the driving attachment may be driven from any other step the range of milling speeds is consequently very wide.

The driving attachment consists of a pulley which is held in a forked bearing. This fork is hinged to a base *c* in such a manner that it may be set at any angle and when so set is firmly clamped by the bolt *b*. The base itself may be clamped at any position along the bed of the lathe by means of the clamping bolt *c*. The fork is hinged about the pin *a*, while the bolt *b* moves through a slot which allows a movement of the pulley of 5 inches, so that the different lengths of belt caused by employing different steps of the cone, may be kept at proper tension. The universal joint *d*, by which the driving attachment is connected with the milling attachment, is capable of working to an angle of 70 degrees.

The milling attachment proper is fastened to the cross slide of the lathe by the two screws *ee* and in no way interferes with the use of the lathe for ordinary purposes. The cutter head is pivoted so that it can be set at any angle from horizontal to vertical and graduations are provided for indicating the angle. It is clamped in position by the three bolts *fff*. In addition to this movement the cutter head has a movement of 7 inches up and down on the face of the column upon which it is mounted, being operated by the screw *k*. These combined movements allow the operator to bring the cutter to bear upon the work in the most advantageous positions. The spindle is very large and formed to receive collets, drill chucks, milling cutters, etc.

The fixture shown at Fig. 3 is for the purpose of indexing the work on the spindle of the lathe. The base of this indexing attachment is clamped to the bed of the lathe by the screw *o* and is provided with a swivel joint similar to that used on the driving attachment, so that the gear *q* can be meshed with the spindle gear or thrown back out of mesh without disturbing the arrangement in any way. Mounted upon the swinging arm is the shaft bearing the gear *q* and having at its opposite end a worm wheel which meshes with a worm mounted on the indexing shaft. The indexing shaft passes through the plate *l* and terminates with an index pin. By the use of this attachment any desired divisions of the circle may be made upon the work as in the regular milling machines.

New Haven, Conn. A. L. MONRAD.

ECONOMICAL BOILER SETTINGS.

Editor MACHINERY:

I noted the criticism of "J. A. P." in the letters of the August issue, and as this is an interesting subject, further discussion of it seems to be in order. He says that the pit in rear of the bridge wall should be filled up in order that the gases may be more thoroughly burned, but his conclusion is not logical. We are told that a large, high furnace is necessary to secure combustion of the fuel, also that we must have a large chamber at the rear for the combustion of gases—all of which seems proper. Then why must we have a small passage behind the bridge wall to secure the same result?

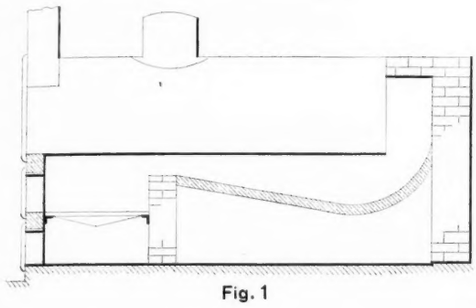


Fig. 1

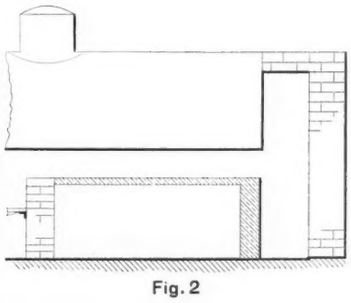


Fig. 2

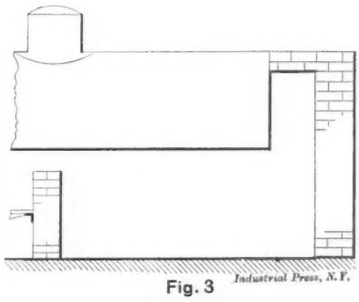


Fig. 3

He mentions a battery of three boilers, two of which gave good results, but the third was less efficient. After a while the third did better work because the space back of the bridge wall filled with ashes, making what he calls a better combustion chamber. I should like to know what method was adopted to determine the efficiency of the third boiler. If the steam was discharged into a main common to all of them, was not the increased efficiency due to the imagination of the engineer in charge, or was a careful test made to determine it? How long was this boiler run before its efficiency increased? Under ordinary conditions it would take about three years for the space to fill with ashes, so as to equal the ordinary method of filling in this space; therefore if the efficiency was really increased within a few months, it was due to some other cause.

A certain engineer had charge of a battery of 10 small tubular boilers. Three of them were taken out and replaced by two larger ones. He had the bridge walls built in the form of an inverted arch, only 4 inches distant from the shells. As the products of combustion were forced through this narrow space the heat was intense at this point, doing the shells no good to say the least, but he always claimed that this plan saved much coal. As the whole battery of 9 boilers discharged their steam into one main it was impossible to tell which boiler was the most efficient, so far as I could judge, and he never could give a reason for his belief; therefore it was an open question, in my opinion, and the same reasoning applies to the third boiler mentioned by "J. A. P."

He mentions another "set of boilers," but does not state the number, in which a saving of 500 pounds of coal was made in 24 hours, by filling in behind the bridge walls. If there were 5 of them it means 100 pounds each, or 40 pounds for an ordinary run of 10 hours. This amount is so small that it would take a long time to pay for the brick work, etc., required, especially when the extra cost of more frequently removing the ashes is considered. Were any other changes made at the same time? What measures were taken to know exactly the amount of water actually evaporated both before and after the change?

If these boilers were of 100 horse power each, and 9 pounds of water were evaporated by each pound of coal, the saving mentioned amounts to but 36 pounds of water per hour for each boiler, and if tests were so carefully made that it is known beyond dispute that this small saving was due to the change mentioned, said tests were of a very superior order, as there are many other things to be considered, any one of which would make more difference than he reports.

While investigating this matter I compared the results of several tests made on boilers that are practically alike, except a difference in the setting. I found reports of five tests made on boilers set as shown in Fig. 1. The average of these is 9.73 pounds of water evaporated per pound of combustible, from and at 212 degrees, which is a proper standard for comparison. Four tests were made on boiler set as in Fig. 2, the average of which was 10.97 pounds. Five tests were made with the setting illustrated in Fig. 3, and the average was 11.28 pounds of water. In one case the pit behind the bridge wall was 7 feet deep. These figures, which were taken in an impartial manner, show results in favor of a large combustion chamber behind the bridge wall, and this seems logical in view of the large space required in the furnace, and at the rear end of boiler.

Many years' experience with this type of boiler satisfies me that it is better to have the space at this point so large that it will not get half full of ashes in a year, than to have it small, making it necessary to clean it out every three months, especially if the rear end of boiler setting is within a yard of a nice engine room door, as in the case of my present plant. We can stand one such job each year, but do not want it every quarter. The lower half of a boiler shell can be inspected and repaired much easier and better, where there is room to do it, than where the space is but a few inches deep, and our boilers are not accessible enough at present, therefore all useless incumbrances should be dispensed with. W. H. WAKEMAN

New Haven, Conn.

[In reply to the above letter we have received the following communication from "J. A. P.," in which he answers the questions raised by Mr. Wakeman.—Editor.]

Editor MACHINERY:

Relative to the remarks by Mr. Wakeman, concerning the suggestions on boiler settings which were offered by me in the August number of MACHINERY, I would say that they were the evidence of practical experience rather than a comparison of efficiency tests, and the conclusions drawn were not entirely original but followed out the idea of a number of able engineers of broad experience in the designing of boilers. It will be readily admitted that we need a large and roomy furnace, but it would be possible to make a furnace too large, and the same reasoning applies to the combustion chamber. Let us consult a few statements of leading engineers relative to the design of a furnace of the most economical type.

Mr. J. W. Shepard, in a paper before the Western Railway Club, makes the following statements, among others, on the subject of combustion: "Let it be said that coal, as such, does not burn. Before any burning can occur the coal must be broken down. The gases evolved are almost all hydrocarbons; these hydrocarbons must also be broken into their component parts, hydrogen and carbon. The real process of burning is the uniting of oxygen, a gas, with the fuel to be burned."

Now since all of the above statements are true, we have placed a limit upon the size of the furnace. As far as the breaking down of the coal is concerned it might be of almost any size, but when it comes to the gases we are limited, because when one atom of carbon unites with two of oxygen we get the best condition for burning, or for uniting the oxygen with the fuel. Since the air contains the oxygen used, we must have our furnace of such a size as will furnish as nearly as possible the required amount of air to supply the oxygen; a furnace abnormally large will contain more air than is necessary and will prove detrimental. Now since the combustion chamber does a large part of the work of decomposing or breaking down of the hydrocarbons into their component parts, and since this latter is a process of burning, we can get too large a combustion chamber as well as too large a furnace. The igniting temperature of hydrocarbons is from 940 degrees to 1,230 degrees, and we should have our combustion chamber up to at least this heat and keep it there. It is quite evident that a built-up combustion chamber is much warmer than a large open space back of the bridge wall. We are told that the ideal furnace is one in which the coal is burned separately from the boiler, only the heated gases being allowed to pass under the shell, and in the path of these gases we may erect pieces which, becoming highly heated, tend to increase the efficiency of the furnace. Now this is the idea of the built-up chamber; its bed is intended to be at the height of the lower strata of gases, or nearly so, and this becoming heated increases the efficiency of the furnace.

Mr. E. P. Parker, in writing upon the subject of smoke abolition, advocates a bridge wall three feet thick, making a combustion chamber of the bridge wall, in a sense. I find also in a design presented by him the built-up combustion chamber in addition to the thick wall.

Mr. G. B. N. Tower, formerly U. S. supervising inspector of steam vessels, presents the following suggestions upon boiler settings: "As gases are generated during the process of burning coal, suitable provision must be made to supply them with air necessary for their combustion. Now this air cannot be supplied through the grate bars, but must be supplied in the furnace above the fuel, and also *at and behind the bridge wall.*" Since air is to be supplied at the bridge wall, is it not far better to so design our combustion chamber that the air which enters shall be compelled to mix with the gases as much as possible, by limiting to some extent its permissible range of movement? This is the office of the built-up chamber.

The three boiler battery which was mentioned in my former article was not under a test, the facts of the case being as follows: When the installation was first made the whole battery was run for some time, then one boiler was dropped out and remained so for about six months. After this time it became necessary to run the third boiler again, and upon starting it up it was found that the first two boilers steamed faster than the third. The feed pipes were removed and cleaned and, as this was the only condition which could make an unequal feed, it was clear that the evaporative efficiency of the boilers which had been run regularly was greater for the reason before mentioned.

In regard to the other set of boilers mentioned it may be stated that there were two, not five. No efficiency test was made at the time, but they simply did the same amount of work after building in as before, and they used 500 pounds of coal less in twenty-four hours. Mr. Wakeman's water saving statement seems to be rather abstract in connection with this subject, as it was a saving of coal for which we were working, not water. We saved no water at all since the same amount of steam was used both before and after the change; we simply evaporated the same amount of water with less coal. Under a carefully-conducted calorimetric test these boilers showed an evaporation of 10.5 pounds of water per pound of coal. In connection with this test it may be well to say that the firing was not of the best, the fireman being somewhat inexperienced. In view of the fact that a run of these boilers before putting in the built-up chamber showed very poor steaming qualities it seems that the change was a decided improvement. With a properly designed combustion chamber there will be ample room for cleaning and inspecting the shell as well as for making repairs. The expense of a combustion chamber built in this way is very small since it requires only a double brick wall, about 5 feet long and 3 feet high, filled in with sand and covered over with brick.

J. A. P.

BEVEL GEAR FORMULAS.

Editor MACHINERY:

It is doubtful if there is any other mechanism of equal simplicity that has called forth as many or as elaborate formulas as has the ordinary bevel gear. This fact appears more strange when we contemplate the simplicity of the essential calculations, and one is led to think that the matter has been slightly overdone. Instead of clearing up matters, this mass of formulas seems to have had a tendency to make the beginner regard the subject with more or less suspicion and dread. Then there is often the man of inquiring mind who would fain acquaint himself with the method of calculating bevel gears, but stands aghast when he finds that between him and the required goal there are a lot of trigonometrical expressions. He is willing to grapple with a few algebraic expressions but when it comes to trigonometry, he draws the line. That these expressions are not anywhere nearly as difficult as a great many are prone to imagine, goes without saying; but, on the other hand, are not these expressions injected into mathematical expressions unnecessarily?

For example: To find the maximum outside diameter of a bevel gear by the ordinary method, we take the ratio of the diameters, or numbers of teeth, and thus ascertain the corresponding center angle from a table of tangents. We then look up the sine and cosine of this angle and from these values and the pitch we obtain the required amounts to add to the pitch diameters of the gear and pinion respectively. This moreover is not as direct as it may seem, since the ordinary trigonometrical tables give only the function of angles varying by 10 minutes so that in most cases interpolation becomes necessary.

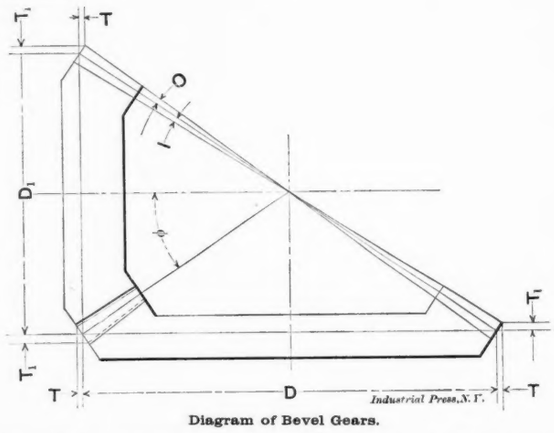


Diagram of Bevel Gears.

In order to avoid all this inconvenience and the consequent liability to err the writer uses formulas (1) and (2) to determine the tooth increments to add to the pitch diameter in order to obtain the outside diameters.

For the pinion, $$T_1 = \frac{D}{P \sqrt{D^2 + D_1^2}} \qquad (1)$$

For the gear, $$T = \frac{D_1}{P \sqrt{D^2 + D_1^2}} \qquad (2)$$

In which

D_1 = diameter of pinion.
D = diameter of gear.
P = diametral pitch.

The calculation made in this way is much simpler than by trigonometry since it necessitates the use of no tables and consequently no interpolation; also it will be noticed that the denominator is the same for both equations.

To find the center angle ϕ we have of necessity to resort to our table to find the angle whose tangent corresponds to the ratio of the gears; that is:

$$\phi = \tan^{-1} \frac{D_1}{D} \qquad (3)$$

Similarly, we have for the inside and outside tooth angles I and O (where the whole depth of the tooth equals 2.157 divided by the diametral pitch).

$$O = \tan^{-1} \frac{2}{P \sqrt{D^2 + D_1^2}} \qquad (4)$$

$$I = \tan^{-1} \frac{2.314}{P \sqrt{D^2 + D_1^2}} \qquad (5)$$

These two values may, however, be determined without trigonometry by an approximate method, giving a result near enough for practical purposes, particularly for a set of gears with a large number of teeth, and by making a slight correction we may obtain as close, or closer, results than by (4) and (5) unless the decimal points are carried well out and values carefully interpolated. The approximation consists in assuming that the depth of the tooth, above or below the pitch line, corresponds to a circular arc with center at intersection of the axes of the gears. The fraction that this angle is of 360 degrees is taken as the fraction that the depth of the tooth, above or below the pitch line as the case may be, is of the whole circumference of this circle. Then

$$O = \frac{360}{P\pi \sqrt{D^2 + D_1^2}} = \frac{114.59}{P \sqrt{D^2 + D_1^2}} \qquad (6)$$

$$I = \frac{416.52}{P\pi \sqrt{D^2 + D_1^2}} = \frac{132.53}{P \sqrt{D^2 + D_1^2}} \qquad (7)$$

The maximum discrepancy would occur with a 12-tooth miter gear where the outside angle is 6° 43′ and figured by formula (6) is 6° 45′. As the results are always large, and increase as the angle, it is a simple matter to make the correction. The table herewith gives the amount in minutes to be deducted from the results obtained from (6) and (7), for various tooth angles.

Tooth Angles in Degrees.	Deduction in Minutes.
1°	.02′
2°	.05′
3°	.17′
4°	.40′
5°	.65′
6°	1.38′
7°	2.08′

To find the number of teeth for which to select the cutter we have:

For the pinion, $$\frac{P D_1 \sqrt{D + D_1^2}}{D} \qquad (8)$$

For the gear, $$\frac{P D \sqrt{D + D_1^2}}{D_1} \qquad (9)$$

The objection to the general expressions for these values, such as the number of teeth divided by the cosine or sine of the center angle, is that before the values can be obtained it is necessary to consult the table and interpolate, whereas, with (8) and (9) the results may be obtained directly.

When one is about to lay out a pair of bevel gears, the diameters and pitch are determined from a consideration of the space available, power to be transmitted, speed, etc. These having been obtained the above formulas enable one to obtain all of the data generally required to construct the ordinary pair of bevel gears, viz., outside diameter, backing, turning and cutting angles, and number of cutter to be used.

J. D. ADAMS.

Phœnix, Arizona.

A GERMAN SPIRAL GEAR CUTTER.

Editor MACHINERY:

In reference to the subject of spiral gears, upon which you have published several articles, it may be of some interest to your readers to state that we are building a special machine for making very accurate gears with helically-formed teeth in a very cheap and quick way. The sale of this machine is growing rapidly in this country (Germany) and people experienced in gear cutting are surprised at its simplicity and the accuracy of its working.

Our cutting tool is a spiral worm cutter and the great feature of the machine is that all spur wheels with straight or spiral teeth, and with any number of teeth, provided they are of the same diametral pitch, can be cut by means of a single cutter. The faults in the completed gear are therefore limited by the errors existing in the single cutting tool, which it is possible to make very perfect, and the work of cutting the teeth is rendered independent of the care and intelligence of the operator.

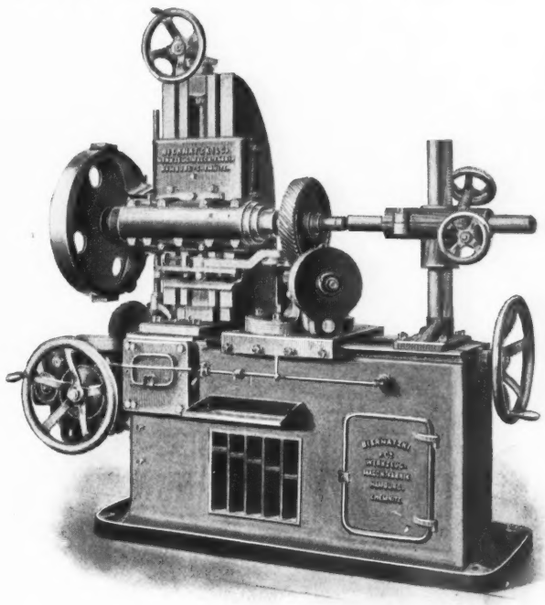
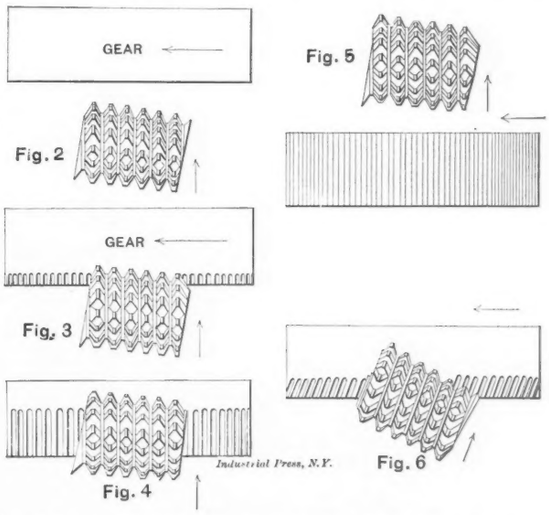


Fig. 1. Spiral Gear Cutter.

In explanation of our system, we will first describe the usual way for cutting an ordinary spur wheel with straight teeth by means of a single-thread spiral cutter. The cutter is supported on a swivel carriage and is set with its axis at an angle with the plane of the wheel to be cut, this angle being such that the plane of the gear will be normal to the spiral of the cutter. Both the cutter and blank are given a rotary motion, the cutter making as many revolutions for each rotation of the spur wheel blank as there are teeth to



Figs. 2-6. Illustrating the Principle of the Spiral Gear Cutter.

be cut in the latter. The cutter is now fed into the blank in a direction parallel to the axis of the latter, whereupon it begins to cut some of the teeth. As the blank rotates, all of the teeth are finally started and by degrees the cutter passes across the face of the blank and gradually cuts the teeth across the full width of its face. This action is illustrated in the diagrams, Figs. 2 to 5, inclusive, in which Fig. 2 shows the angular position of the spiral cutter before

commencing work; Fig. 3 its position after the wheel blank has completed one revolution; Fig. 4 its position after about one-half the width of the teeth has been cut, by a corresponding number of revolutions of the wheel blank; and Fig. 5 shows the finished spur wheel, with the cutter moved beyond it.

Our method for cutting spiral wheels differs from that above mainly in that the number of revolutions of the spiral cutter, necessary for cutting a straight-toothed wheel as above described, has to be increased, say, by one revolution, while the number of revolutions of the wheel blank remains the same as before. This one additional revolution of the cutter, taken in connection with its advancing motion, gives as resultant the helical direction required for the teeth of the spiral wheel. This action is indicated at Fig. 6. It will be evident, however, that any other proportional increase of the number of revolutions can be employed such, for instance, as two, three or more additional revolutions or a fraction of a revolution, according as a greater or smaller pitch of the spiral teeth may be required. The number of revolutions of the cutter could also be reduced by one or more revolutions or fractions thereof, as above stated, instead of being increased, producing helical teeth of the opposite pitch having an opposite inclination of the axis of the spiral cutter.

In a like manner spiral wheels having an angle of spiral varying from zero to 180 degrees can be cut by one and the same spiral cutter, according as the cutter has one or more additional, or one or more less revolutions imparted to it.

These machines are patented in the United States and manufactured in our factory in Germany. The following is a summary of the advantages of the system:

1. The machine is simple in construction and easy to handle.

2. Only one cutter is required for different wheels containing different numbers of teeth, provided they are of the same pitch.

3. This greatly reduces the cost of cutters, it being only about one-half as compared with other machines with which it is necessary to use a set of 8 or 14 cutters for each pitch.

4. The form of tooth is absolutely and theoretically correct for wheels with any number of teeth and not correct by intervals only, as is the case when a set of cutters has to be used for each pitch.

5. Being formed by the same cutter, the teeth of all wheels of the same pitch, though containing different numbers of teeth, are of equal thickness at corresponding heights, consequently gears cut by this machine work smoothly and without backlash.

6. No previous nicking or preparation of the solid blank on a dividing machine is required, the machine doing its own dividing automatically during the process of cutting.

7. As several teeth of the cutter are working at once, the capacity as compared with the ordinary spur wheel cutter is much greater.

BIERNATZKI & CO.

Hamburg, Germany.

[This type of gear cutter is not unknown in this country, but, for some reason, no manufacturer here has made one operating on this principle a commercial success. We do not know why this is the case, for we learn from other sources, as well as from the above communication, that machines of this type are thought well of abroad and will do very rapid work. One possible reason for its non-development here is that there must necessarily be more or less elasticity in the train of gearing connecting the cutter and wheel being cut, and this may have been believed fatal to the proper performance of the work. Stiff and rigid construction, however, have evidently overcome this defect.

It will be observed that a gear cutter on this principle is but an extension of the principle of the worm-wheel hobbing machine manufactured by several firms in this country. What was probably the first of these machines was invented by Sir Joseph Whitworth in 1835, and since then many other patents have been issued, here and abroad, both on machines for hobbing worm-wheels and for cutting spur and spiral gears with spiral cutters. In 1889 Geo. B. Grant took out a patent on what he called a "Conjugator," a machine operating on substantially the same principle as the machine described above, though of not so good mechanical construction. Following upon Mr. Grant's invention William Sellers & Co., Philadelphia, did some experimental work in this direction, but for some reason did not see fit to develop the machine sufficiently to put it on the market. If it should happen that this letter of Biernatzki & Co. should bring out any further information upon this method of gear cutting, we should be glad to lay the facts before our readers.—Editor.]

* * *

THE STRENGTH OF FIXED END COLUMNS UNDER LATERAL THRUST.

Editor MACHINERY:

Every once in a while a person comes across something in engineering which he must think out for himself, as one is unable to find any information in the text books on the subject. One of these cases is shown in Fig. 1. The column, *P*, has one end fixed in a permanent structure, *B*, while the other end of the bar is also fixed in another structure, *A*. The latter has a lateral thrust, *W*, acting upon it. As the diameter of *P* was to be kept as small as possible, it became necessary to know what bending moment was exerted by the thrust *W*.

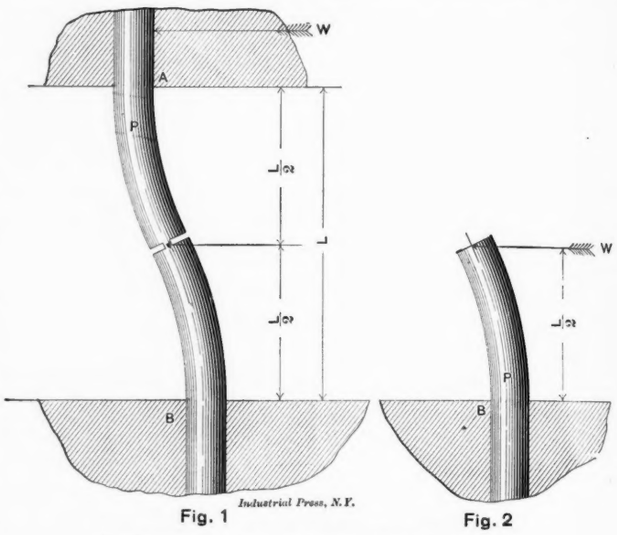


Fig. 1 Fig. 2

Illustrating Strength of Columns under Lateral Thrust.

When the force was acting upon the beam, it would assume a reverse curve, as shown in Fig. 1, *A* being so arranged that it had to move parallel to *B*. The inflection point of the curve would be midway between *A* and *B*, and as the curve changes at this point, from plus to minus, the outer fibers of the beam would neither be in tension nor compression, and, therefore, if we should saw out the metal on each side, as shown, and suppose that a single fiber was strong enough to take care of the shear at this point, we would not have altered the curve or bending moment.

If the thrust *W* were now transferred to the center, and the remaining fiber removed, as shown in Fig. 2, the bending moment of the support would be unaltered. This bending moment is seen to be $\frac{WL}{2}$ which is ½ that of a simple beam of the length, *L*, with a load on the end. This beam, therefore, need only be made one-half as strong as a beam which would not be fixed at *A*. The maximum bending moment would be at the fixed ends and would be $\frac{WL}{2}$.

FRANK B. KLEINHANS.

PATTERNS AND PATTERN ROOM.

Editor MACHINERY:

Since patterns form a valuable asset in any business they should have the best of care and a careful and complete record should be kept of them. Many concerns who own patterns recognize this fact and have a system that is in keeping with the valuable and important part which these patterns have in the conduct of business. There is no reason why costly patterns should be in general disorder most of the time and

usually covered with dust and dirt. There is no reason why they cannot be kept as clean as the books in the office or papers on the desk, and there is every reason for keeping them in the best of order and condition.

A little daily care and attention to the pattern room will be well repaid by the improved condition of the patterns and the general appearance of the room. There are times when one desires to show business friends around the plant, and how much satisfaction there is in a well-kept, clean and light pattern room. It is, indeed, strange how some men of good business acumen will look at the condition of some parts of their plant without a pang, and it is especially strange that they should take so little interest in the care and condition of patterns which have taken much valuable time to produce.

When a pattern is needed it is often needed in a hurry, and some scheme should be devised to locate it quickly and with facility. It is decidedly unpleasant, and irritating in the last degree, to experience trouble in locating a pattern when there is a rush order for castings from it, and no accurate record to show where it is or who had it last. The value of systems is brought out over and over again in the daily operation of the pattern shop and in no place can a system be utilized to greater advantage. Many shops have systems for keeping run of their patterns that are as good, or perhaps better, than the one that is here described, but to those that have no system the following outline may prove of benefit.

The pattern room should be in charge of one man, and he alone should have the entire oversight and be responsible for the condition of the room and patterns, and of the records connected therewith. It is always a good policy to concentrate responsibility as much as possible and, when it is practical to do so, to place one man in charge of certain departments of work, making him directly responsible for the conduct and general condition of that department. Of course there is the human element of fallibility, but the danger of mistakes can be reduced to a minimum by this one-man responsibility, leaving no opportunity for shifting the burden on others. A man having charge of the pattern room must of necessity know something about the business and about patterns in general. In some shops it is practical to turn the room over to the pattern maker and make him responsible for its condition, records, etc. This, however, cannot be done in large shops where the entire time of the pattern makers must be employed in the making of patterns, and so a man should be selected who can devote as much of his time as may be necessary to the care of this room.

It is, of course, difficult to determine just how much room should be set aside for the storage of patterns, but it should be borne in mind that conservatism in this matter is not economy, nor is it good judgment. If there is any branch of the business that increases rapidly it is the pattern department, and this fact should be taken into consideration when making plans for the pattern room. It is a still more difficult problem to arrange the shelving for the patterns, but the common shelf has proved the most satisfactory in the long run, and to this end a set of shelves should be arranged around the room on all four sides. These may be from two to three feet deep, and a trolley ladder should be employed to reach the top shelves quickly and easily. The center of the room may be utilized for the erection of another set of shelves which will be open at both sides. Very large patterns that will not go on the shelves may be arranged around the room on the floor. As the shelves are erected they should be divided off into compartments of about two feet each, so that when all of the space in a compartment has been utilized a small board tag may be suspended from the top shelf showing just what numbers are in that compartment. This will greatly facilitate the location of the patterns. When the patterns are placed in the room, insist that they be dusted every day and the room swept and cleaned as thoroughly as an office. In this way it will not be hard work to keep rooms and patterns in first-class order.

There are many different ways of designating patterns, but, in the opinion of the writer, the simple method of numbering them consecutively as they are made is the best and the least liable to confusion. In the matter of record the versatile card index is called into play. Give each pattern a card rather larger than the standard size, say 6 inches by 5 inches, and on this put the number and name of the part or piece for which the pattern is made. It will also be found desirable to keep on the record the date when the pattern was made, the cost in detail, and the weight in iron, steel, or whatever metal is used for the casting. On the reverse side a record should be kept showing the movement of the pattern, whether at home or away, and it should be impressed with special emphasis that this record must be complete and accurate. This will prevent many of the disputes and disagreements that often occur owing to inaccurate records of the whereabouts of patterns, and much trouble and delay will be avoided if the record is kept as it should be.

This system can be used by foundries doing a jobbing business by a little change in the matter of record shown on the card. In this case the record should show to whom the pattern belongs, when received, weight in metal, cost of casting and the number and name of the pattern.

W. G. Stebbins.

New London, Conn.

* * *

PEAT AS FUEL.

Since the coal famine of a year ago various sources of fuel other than the coal fields and forests of the country have been proposed—among them the peat bogs, found in many localities. The mud from these bogs consists partially of carbonized vegetable matter, caused by the decomposition of water plants, moss, grass, etc., intermingled with fibrous roots, and when dried out makes an efficient fuel. Another kind of peat, which may be designated as turf peat, consists of the mud which is found under the turf that grows in marshy places, the carbonized vegetable matter in this case consisting of decayed grasses or turf.

While it is generally known that peat will serve as a fuel, and that it is so used in some countries very extensively, it is only recently that authentic information as to its calorific power and characteristics appears to have been available. A bulletin of the Insurance Engineering Experiment Station, Boston, Mass., is devoted to the subject of "mud-fuel, coke and gas," showing that peat may be considered an emergency fuel, if nothing more.

The report refers to the Ziegler process—a German invention—for converting peat into coke and gaseous products, showing very low cost of production, based on the German scale of wages, which would have to be offset in this country by improved mechanical processes, should the manufacture of coke and by-products from peat be undertaken on a commercial scale. The report also contains the results of tests by Prof. Norton of the Massachusetts Institute of Technology, Boston, showing that the calorific power of air-dried peat, when "bone-dry," is from 9,600 to 14,000 B. T. U. per pound, or about 65 per cent. that of the best American coal. Prof. Norton makes comments on the use of peat and draws several interesting deductions. Samples of peat when wet weigh 100 to 125 pounds per cubic foot, and after drying in the air the weight reduces to about 55 pounds, when the mud becomes hard and tough, difficult to saw but easy to split with an axe. In the process of coking the tendency is for the mud to crumble; but if it is first dried thoroughly it produces a firm, dense coke, very much like the coke from soft coal. With 43,560 feet to the acre and depth, say, of 20 feet, there would be 860,000 cubic feet of mud per acre, which would yield 20,000 tons of air-dried mud, equal in heating power to 12,000 tons of good coal. If convenience in handling and diminished bulk should justify the coking process, 10,000 tons of good coke would be produced, and as there is almost, if not quite, enough gas distilled from the coke to make one pound of mud furnish the gas to coke the next, the process once started would require no extra fuel.

The success or failure of peat as a fuel here in America would seem to rest entirely upon the cost of excavating and drying it, compared with the cost of mining coal, taking into account the interest charges on the equipment. As long as anthracite coal is to be had, even at a high price, it will be preferred, because of its cleanliness, and high heating power; but in the case of fuel emergency here in the East, where people in general are accustomed to soft coal, it would seem as though peat might serve as a very efficient emergency fuel.

THE CARD INDEX IN THE DRAFTING ROOM.

REGARDING ITS USE BY THE DRAFTSMAN FOR HIS INDIVIDUAL RECORDS.

During the past few years the use of books for the keeping of records has been giving place to the more modern method of record keeping—the card index system. Introduced first in mercantile business, its use has extended, until now it is found in almost every branch of work in which the keeping of any kind of records is involved. In the up-to-date drafting room the card index found early acceptance for keeping records of drawings and similar purposes. There is, however, a place in the drafting room for the card index where it has yet to be more generally adopted, and that is as an individual adjunct to each draftsman's outfit. Years ago Nystrom said: "Every engineer should make his own pocketbook, as he proceeds in study and practice, to suit his particular business," and there is no better way of compiling a pocketbook than by the use of the card index. Outfits for this purpose may be purchased in all styles and prices, from the trial outfit of 3 x 5 cards, in a pasteboard case and costing about 75 cents, up to the most elaborate cases and trays for the 5 x 8 cards. As the individual index is of value primarily only to the draftsman using it, it may be difficult to persuade the "Company" to provide such outfits, so that as a beginning it may be necessary for the draftsman who is desirous of starting his own collection of data to provide himself with an outfit composed of materials that can usually be found at hand.

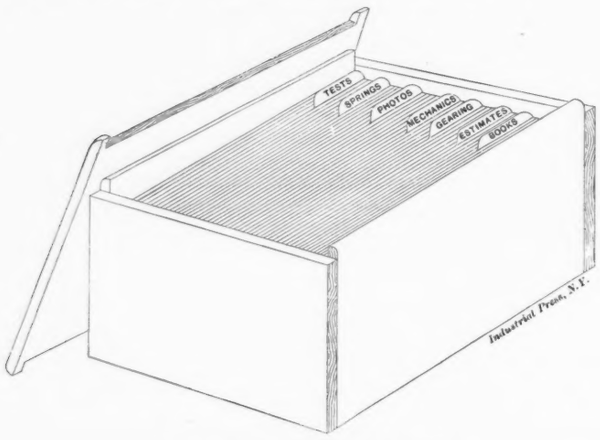


Fig. 1. A "Shop-made" Card Index Box.

Fig. 1 is a sketch of a very cheap and serviceable index box that can be readily put together in the pattern shop and is in some ways better suited to this particular purpose than those purchased of the regular dealers in such goods. Being made of ½-inch pine, planed down to about ⅜ inch, it is very light and much more easily handled than the regular cases, which are usually made of oak. Another point in its favor is that it can be made much shorter than any of the regular trays which come in lengths of from 12 to 14 inches, and are, therefore, of a size that would prove unhandy upon a draftsman's board. A package containing 100 index cards of medium weight measures a little less than an inch in thickness, so that a box 4 or 5 inches deep will hold a sufficient number of cards to cover a long period of the average draftsman's experience. The object should be to compress the entire outfit into a size and weight which shall not greatly exceed that of an ordinary reference book.

Cards for these outfits are provided mainly in 3 x 5, 4 x 6, and 5 x 8 inch sizes, but if the index is to be put to all of the uses which are mentioned later, the cards should not be less than the 4 x 6-inch size. Either of the two larger sizes, if used in a short, light tray, will be found fully as convenient to handle as the ordinary tray for the smaller cards when it is of the usual length and constructed of oak. The cards chosen should be of sufficient size to allow of fairly lengthy computations, and for mounting complete tables and similar data clipped from periodicals. If home-made cards are to be used they can be easily cut from Manila or stiff white drawing paper, and will answer the purpose very satisfactorily. Guide cards are cut from the same material and labeled to suit the matter to be indexed. In the case illustrated no provision whatever is made for locking the cards in as none is considered necessary. When it is desired to refer constantly to a certain card or cards they may be easily slipped out and placed on the drawing board for the time being and any device which makes it necessary to lock and unlock in order to do this, or to remove and add cards, will, after a short trial, be found to be more of an objection than an advantage.

The uses to which the index can be put will suggest themselves to each draftsman as the requirements of his work

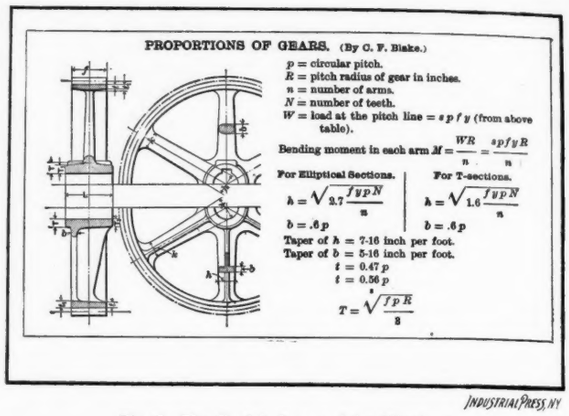

PROPORTIONS OF GEARS. (By C. F. Blake.)
p = circular pitch.
R = pitch radius of gear in inches.
n = number of arms.
N = number of teeth.
W = load at the pitch line = s p f y (from above table).
Bending moment in each arm M = WR/n = spfyR/n
For Elliptical Sections.
h = √(2.7 fypN/n)
b = .6p
For T-sections.
h = √(1.6 fypN/n)
b = .6p
Taper of h = 7-16 inch per foot.
Taper of b = 5-16 inch per foot.
t = 0.47 p
t = 0.56 p
T = √(fpR/3)
INDUSTRIAL PRESS, NY

Fig. 2. The Card Index used for Clippings.

present them. In the first place there are certain tables to which every draftsman has constantly to refer, and these should form a foundation of the index system. Such data as decimal equivalents, squares and cubes, trigonometrical functions, etc., furnish the most natural beginning. These are to be found in the handbooks in common use, such as Kent and Nystrom, but when only one table is needed for a particular use the convenience of drawing out a single card over the necessity of handling the whole book, will at once be apparent. Often several tables are used at the same time, and then the pages of the book must be turned back and forth, or, perhaps, two or more books must be referred to. With the index system any number of cards may be placed side by side where the draftsman may refer to them without trouble. Having started with the tables most commonly used the index will grow with considerable rapidity. If any unfamiliar table or data is to be consulted, much time may be lost in searching for it through the different handbooks, but if, when found, it

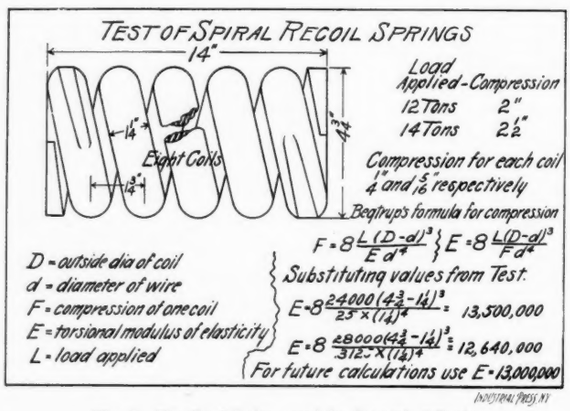

TEST OF SPIRAL RECOIL SPRINGS
14"
Load Applied - Compression
12 Tons 2"
14 Tons 2½"
Eight Coils
Compression for each coil 1/4" and 3/16" respectively
Beqtrup's formula for compression
F = 8 L(D-d)³/Ed⁴ E = 8 L(D-d)³/Fd⁴
D = outside dia of coil
d = diameter of wire
F = compression of one coil
E = torsional modulus of elasticity
L = load applied
Substituting values from Test.
E = 8 24000(4¾-1¼)³/25×(1/4)⁴ = 13,500,000
E = 8 28000(4¾-1¼)³/.312×(1/4)⁴ = 12,640,000
For future calculations use E = 13,000,000
INDUSTRIAL PRESS, NY

Fig. 3. The Card Index used for Record of Tests.

is copied on to an index card, it is then ready for immediate use if again needed. Clippings from periodicals have before been referred to, and the value of a year's subscription to any good technical publication will be wonderfully increased if all of the data that is published pertaining to one's particular line of work is placed upon the cards. Fig. 2 is an illustration of a data card upon which is mounted one of the tables taken from a MACHINERY data sheet.

Reviews of all technical books that the owner reads should find a place upon these cards. To thoroughly digest any book there is no better plan than to make notes and extracts as

the reader proceeds, and if these are afterward placed in his index, they will often prove of the greatest value.

In many drawing rooms the draftsman is provided with a note book in which to record all calculations, estimates, and other computations that may arise in connection with his work. After one of these books has been in use for several months, and a mass of calculations has accumulated therein, it is a most tedious job to search them over for the figures applying to the matter in hand. If, however, the calculations are made upon index cards and filed under appropriate headings, they may be found at a minute's notice.

A draftsman is often called upon to design certain pieces of mechanism in which the strength of the material must be taken from general data and may vary considerably from the strength of the material actually used. In such a case it may be practical to make subsequent tests and from these to obtain definite data. The card shown in Fig. 3 is taken from the writer's index and serves to illustrate the way in which the results of such tests can be recorded. The problem in this case was to design a spring that should stand a load of about

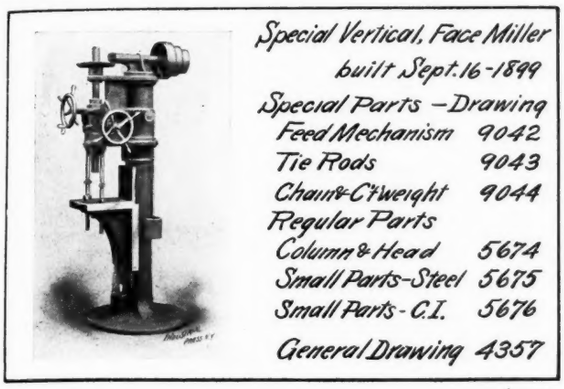


Fig. 4. The Card Index used for Record of Special Machines.

25,000 pounds and to determine its deflection when loaded. The spring was designed and the compression figured by Begtrup's formulas, in which the modulus of elasticity is given as from 10,000,000 to 14,000,000, and the exact modulus to be used is left to the judgment of the designer. After these springs were made they were tested, with the results shown on the card, and substituting the actual deflection for given loads we are able to determine a modulus of elasticity, in this case about 13,000,000, which can be regarded as comparatively exact data for use in designing springs that are to be made of the same material and to perform similar duty. If similar comparisons be made of castings and forgings of various kinds we soon accumulate a quantity of very reliable information that applies more closely to our particular cases than any published data which must, at best, be only general in its nature.

Photographs of machines built, and data connected with them, will prove valuable additions to the index. Fig. 4 shows a record of special vertical milling machine, and explains just which parts were special and which regular, and provides a complete record of the drawings used and any information that would be of aid to the draftsman if called upon to design a similar machine at some future time.

* * *

ITEMS OF MECHANICAL INTEREST.

RELATION OF TRIGONOMETRICAL FUNCTIONS — SURFACE PLATE FOR LONG LEVERS — THE INVENTION OF BABBITT METAL — THE PRODUCTION AND USE OF CARBORUNDUM.

From investigations made in Germany it appears that wood which has been floated in rafts, or has in any way been for a long time immersed in flowing water, is better fitted for reliable joinery and building purposes. The water dissolves the sap, albuminous and salty substances in the pores and makes the wood less hygroscopic, that is, less likely to absorb dampness. Kiln-dried lumber containing large quantities of sap, may shrink, split or warp under certain conditions, but the liability of doing so is much lessened in the case of floated timber. The same condition can be obtained artificially. In a German process for drying wood described by Consul-General Hugue of Coburg, Germany, the boards or planks are piled up in a long iron box, with narrow spaces between; the lid is then tightly screwed down, so that neither water nor steam can escape. Steam is then turned into the box at a continuous pressure (3 to 5 pounds per square inch), and this process is continued for from sixty to seventy-two hours, the exact length of time being determined by the hardness and density of the wood. The steam opens up the wood and kills the protoplasm which is still alive in the cells. After having been thus prepared, the wood goes into a water bath, where it is kept for about a fortnight. The drying process then follows.

To shoot, yet not to shoot, is the problem solved by a Swedish inventor, for the protection of those in the vicinity of young army greenhorns who are learning to become marksmen, as well as to save ammunition now wasted in practice. The apparatus comprises a dummy gun mounted on a universally mounted support so that the gun may be pointed in any direction. A pointer, whose position is controlled by the position of the gun, indicates the slightest movements of the latter, and at the moment the trigger is pulled the pointer is automatically locked in the position at which it was at that instant. Graduations near the pointer show the direction the gun was pointing when the shot was supposed to have been fired and register the deviation from the bullseye that would have occurred had a real rifle been aimed at the same angle as the dummy gun fired by the pull of the trigger.

THE RELATION OF TRIGONOMETRICAL FUNCTIONS.

Prof. W. H. Wilson has prepared a diagram that illustrates in a very concise manner the symmetry of the relations of the trigonometrical functions. A careful study of this diagram, which is here reproduced, will prove of great aid in memorizing the relations which these functions bear to one another. Referring to the cut it will be seen that:

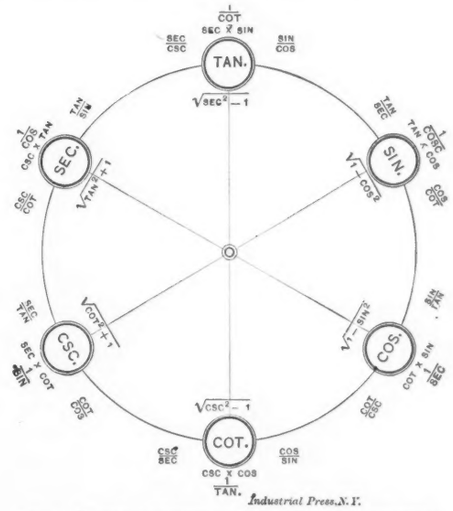


Fig. 1. Showing Relation of Trigonometrical Functions.

Each function is the reciprocal of its diametrical opposite.

Each function is equal to the ratio of the first and the second in either direction.

Each function is equal to the product of its two adjacents.

Each function is equal to an expression involving the square of an adjacent, a radial and unity.

DIE WORK ON A LARGE SCALE.

In this country some of the heaviest die work has been the rather unpleasant but exceedingly interesting process of manufacturing coffins of metal sheets by means of a heavy press and dies. *Page's Magazine*, London, however, describes the process of the Heslop Seamless Steel Boat Works, an English concern, which affords an illustration of die forging or pressing on an immense scale. It is not found practicable to press a boat from one sheet of steel, due to the puckering

of the sheet, so all boats are pressed in halves, and afterward jointed along the keel. There is an advantage, however, in this, namely, that it permits of the insertion of a stiff keel of I section, bent to the required curves, to which the thin flanged edges of the halves are riveted. With the exception of this, all the boat fittings are of timber. The advantage of the steel hull is that it does not shrink as timber does, in hot climates, and that a blow will only bruise, without fracture occurring. The firm turns out some three hundred boats a year. The dies used are so massive that they are built up and bolted together in sections. The cost of the entire stock of dies for boats of different sizes up to 35 feet and 40 feet in length, must have been enormous. The dies are arranged in line with the heating furnace, out of which the sheet to be pressed (of ⅛ inch steel) is drawn. It is located in place on one edge of the lower die by means of cotters driven by men stationed in a row. The lower die is then lifted hydraulically, and the sheet pressed to shape at once.

SURFACE PLATE WITH V-GROOVE FOR LAYING OUT WORK.

In the construction of the linotype machine a number of long light levers have to be mounted on comparatively slender shafts at right angles to same and certain holes have to be located in the levers in accurate relation to one another. In the shop of the Ott. Mergenthaler Co., Baltimore, Md.—who were the original builders of the linotype machine—a surface plate was used for this work and is still used for similar work. In fact the scheme is one that can be profitably em-

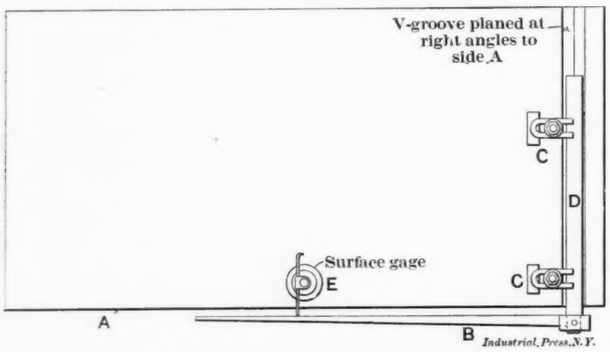


Fig. 2. Surface Plate for Laying Out Long Levers.

ployed in many shops as a time-saver and promoter of accurate work. In the plate a V-groove is planed across one end exactly at right angles to the side *A*. Holes are tapped along the side of the groove for clamps. A shaft with its lever is shown in position for laying out holes in the lever. The shaft *D* is clamped in the V-groove so that the arm *B* stands along the side *A*. With calipers the right angularity can be tested. Holes can be laid out in any desired relation by means of a surface gage, etc.

REGARDING THE INVENTION OF BABBITT METAL.

Although "babbitt" metal is one of the most common antifriction metals in use at the present time, but few users of this metal are aware that Isaac Babbitt, whose name it bears, was the inventor and patentee of the method of lining boxes with soft metal rather than of any particular alloy of the metal itself. The *Metal Industry* recently published a copy of the original patent, No. 1,252, which was granted to Isaac Babbitt, of Boston, Mass., July 17, 1839. In this he claims to have invented a new and improved mode of making boxes in which gudgeons or journals are to run. To quote from that part of his patent relating to the metal used, he says: "I prepare boxes which are to be received into housings or plummer blocks in the ordinary way of forming such boxes; making them of any kind of metal or metallic compound which has sufficient strength and which is capable of being lined. The inner parts of these boxes are to be lined with any of the harder kinds of composition known under the names of britannia metal or pewter, of which block tin is the basis. An excellent compound for this I have prepared by taking 50 parts of tin, 5 of antimony, and 1 of copper. But I do not intend to confine myself to this particular composition."

No claim whatever is made for the composition and, in fact, that specified is somewhat softer than what is now known as "Genuine Babbitt," which is commonly composed of 96 parts of tin, 8 parts antimony, and 4 parts copper.

Although Babbitt's name is somewhat erroneously applied to the metal yet, as he was the first to exploit the use of soft metals in the manner in which they are now so commonly employed, it seems but just that his memory should be perpetuated in this way. After devoting some time to the production of metals he engaged in the manufacture of soap and his name is now as well known in the household as in the shop.

CUTTING LEFT-HAND THREAD WITH RIGHT-HAND TOOLS.

A correspondent of the *American Electrician* shows a slight variation of the old scheme of cutting a left-hand thread on a rod by means of a right-hand tap, inasmuch as he shows how to do it with a die-stock, whereas the ordinary plan is to use a vise in combination with a tap and a V-block. The accompanying sketch shows the arrangement. The dies are opened sufficiently to admit a right-hand tap of the desired lead, and the rod to be threaded. The rod is backed up by a piece of

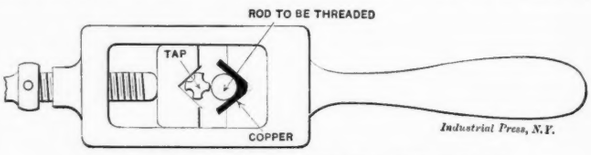


Fig. 3. Cutting Left-hand Thread with Right-hand Tap.

annealed copper into which the threads may imbed themselves without injury. The die should be of the same lead as the tap, which permits the tap being accurately meshed with its thread. With this combination it is claimed that a fair left-hand thread may be cut with the ordinary right-hand equipment. It now remains for some ingenious reader to show us how a left-hand nut can be cut with extemporized tools.

WHY ALUMINUM IS NOT EASILY SOLDERED OR PLATED.

The ever-present, invisible film on an aluminum surface, has a great influence on the success of various operations, especially soldering. The film is supposed to have considerable strength and continuity, and if it is broken or removed by mechanical means the aluminum immediately forms a new one. In soldering aluminum the principal difficulty seems to be due to the failure of the alloy used as a solder to adhere to the aluminum, a condition attributable to the protective film, which must be eliminated before the metals can unite. A successful solder consists of about 21 per cent. of zinc, 76 per cent. of tin and 3 per cent. of aluminum; it may be applied directly to a cleaned aluminum surface without the use of a flux, and at a temperature but little above that which is necessary for soldering copper or iron. There are certain advantages in the apparent complication which the use of a flux involves; a suitable solvent for the oxide film increases the rapidity of the soldering process, increases the certainty of adhesion and enables cheaper soldering mixtures to be used. The requirement for such a flux is that it should dissolve the coating and leave a clean surface for the solder to unite with, upon application of heat; it seems that water cannot be a component of a suitable flux. A material which, for certain solders, forms an admirable flux, is stearic acid; by applying it to a freshly scraped aluminum surface and then applying a tin-lead-zinc alloy, the matter of soldering aluminum presents scarcely greater difficulties than does the soldering of other metals. This almost ever-present coating upon aluminum is also the source of difficulty in the deposition of a permanent coating of other metals upon aluminum surfaces; while it is very easy to deposit a layer of metal upon aluminum from almost any plating solution, in the great majority of operations the resulting coating can readily be removed, sometimes in remarkably thin and continuous layers. The prime requisite in

successful depositions on aluminum is the complete removal of the protection film, so that the electro-deposited metal may be applied over the complete surface of and in intimate contact with the aluminum; if this condition is fulfilled, and the coating is non-porous, it will be durable. The converse of this operation, *i. e.*, the electro-deposition of aluminum upon other metals, appears to be impossible from aqueous solution.—*Electrochemical Industries.*

AN EQUATING MICROMETER.

A very ingenious micrometer and recording gage, of English design, is illustrated in Fig. 4. The micrometer portion of this instrument follows the usual lines of construction except that the barrel, which is usually knurled, is in this case formed into a multiple threaded worm which operates a disk mounted below and carrying a series of figures representing various equivalents of the measurement made by the jaws of the micrometer. A bracket is fastened to the bow of the micrometer for carrying this worm disk and there is also a fixed disk which stands in front of the revolving one and has a series of holes through which the numbers on the revolving disk become visible as the worm is rotated.

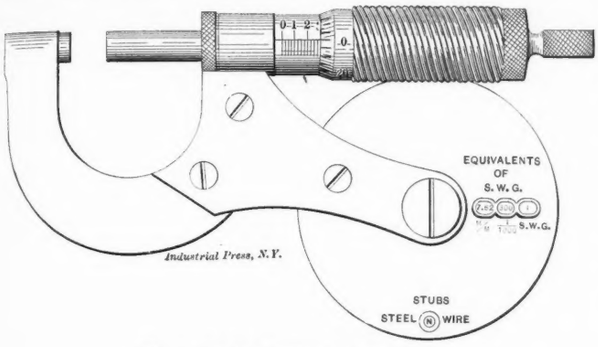


Fig. 4. English Equating Micrometer.

As shown in the cut, the jaws of the micrometer are set at .3 inch and on the dial may be read its metric equivalent 7.62 mm; also 300, denoting the number of thousandths; and 1, over S. W. G. indicating that .3 is the equivalent of No. 1 Stubs wire gage. At the bottom of the disk is another dial for Stubs steel wire in which the size *N* is indicated. This, however, is slightly misleading, as the letter will not occupy the exact center of the opening until the jaws of the micrometer have been moved .002 inch more, giving an opening of .302. A line on the worm disk corresponding with a similar line on the beveled edge of the hole in the outer disk indicates when the exact opening is reached. It is, of course, perfectly practical to apply this arrangement to any kinds of measurements for which the micrometer may be used, and in place of the equivalents here indicated we might have fractions of an inch, sheet metal gages, screw sizes or any other equivalents that might be desired by the user. This instrument is manufactured by Grimshaw & Baxter, London, England.

THE PRODUCTION AND USE OF CARBORUNDUM.

From the new catalogue just issued by the Carborundum Company, Niagara Falls, N. Y., we extract the following interesting information in regard to the production and use of carborundum, which they are producing in large quantities by the aid of electric power furnished by the Niagara Falls Power Co.

The crude materials which are used in the production of carborundum are sand, coke, sawdust and salt, and the first step taken is to reduce the coke to kernels of suitable size to be used as core, and ground to a fine powder to be used in making the mixture or charge for the furnace. To effect this the coke is first passed through a grinder which breaks it up into small pieces. It is then conveyed to the top of the building where it is passed successively through two cylindrical screens, the first of which removes all particles of coke which are too small to form the core, while the second allows kernels of requisite size to pass through its meshes and fall into a core bin, conveniently situated as regards the other constituents of the mixture. Below this bin are scales on which the sand, coke, sawdust and salt are weighed out in proper portions and then conveyed by an elevator to the mechanical mixer, from which the mixture, ready for use, is emptied into a bin.

In the furnace room are fifteen furnaces, built of brick in the form of oblong boxes, the internal dimensions of which are 16 feet in length, 5 feet in depth and 5 feet in width. In the center of the ends are the electric terminals consisting of carbon rods. The side walls of the furnace are first built up to a height of about four feet. The mixture is then thrown into the furnace until it is rather more than half full. A semicircular trench is now formed, the bottom of the trench being a little above the level of the bottom row of carbons, and into this trench is introduced the core. The top is rounded off neatly by hand, so that when finished a solid cylinder 21 inches diameter by about 14 feet long is produced, composed of small pieces of coke, and extending from either end of the furnace. The walls are now built up to a height of about 5 feet and the mixture thrown in and heaped up to a height of about 8 feet.

The electric current by which the furnace is operated is received from the Niagara Falls Power Co. at a pressure of 2,200 volts and must be transformed to lower voltage before passing through the furnace. One of the largest transformers in the world is used to reduce this current to 185 volts, but it may, by means of a regulator, be raised to 250 volts or reduced to 100 volts. The current is at first raised so as to overcome the resistance of the core, which is always greatest when new, but after about an hour the resistance decreases to normal when but little regulation is required, and the volume of the current has increased to a point where 746 kilowatts is expended in heating the furnace. This is continued for a period of about 36 hours after which a few hours more are allowed for the furnace to cool. Then the side walls are taken down and the unchanged mixture raked off from the top until the outer crust of amorphous carborundum is reached. This crust is cut through with steel bars and can then be easily removed from the inner crust of amorphous carborundum. The inner crust is then removed with a spade and the crystalline carborundum exposed, radiating from the core in beautifully colored crystals to a distance of ten or twelve inches. A single furnace yields about 7,000 pounds of crystalline carborundum.

After the carborundum has been removed from the furnace it is taken to a crusher where it is passed under rolls that break the mass of crystals apart. From here it is taken to wooden tanks where it is treated for several days with dilute sulphuric acid to remove all impurities. Then it is thoroughly washed and graded. There are twenty grades of crystals, from No. 8 to No. 220, the numbers indicating the meshes to the linear inch of the screen through which the crystals have passed. The washings pass through a series of tanks which serve to collect the fine powders, and from these are made the so-called "flours" and hand-washed powders.

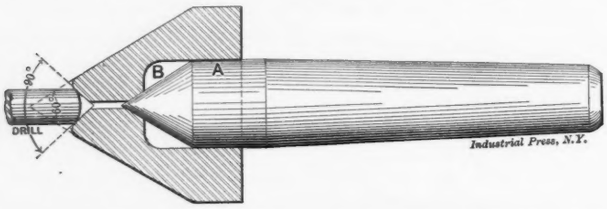
Carborundum is apparently infusible and is quite insoluble in water or any acid. Its hardness lies somewhere between nine and ten degrees, probably very close to ten degrees, which is the hardness of the diamond. Its specific gravity is 3.123, which is less than that of emery, one and one-quarter pounds of the latter being equal in volume to one pound of the former. It is used mainly for grinding wheels of all kinds and also in the shape of sticks, knife sharpeners, hones, scythe stones, cloth, paper, etc.

In the manufacture of the wheels, the carborundum is mixed in certain proportions with kaolin and feldspar, and the mixture is then placed in a mold and pressed in a hydraulic press. The wheel, when removed from the mold, is placed on a support called a "bat," which is made of baked clay. The vitrification of the wheels is carried on in kilns similar to those used in making porcelain. The "bats" upon which the wheels rest are placed on clay in "saggers" and are then built up in columns until they reach the roof of the kiln. When the kiln is filled it is closed and fired, an operation occupying about seven days, and is then allowed to cool slowly. When the wheels are removed they are placed in lathes and trued up with a dresser or diamond.

CONTRIBUTED NOTES AND SHOP KINKS.

AN IMPROVED FORM OF PIPE CENTER.

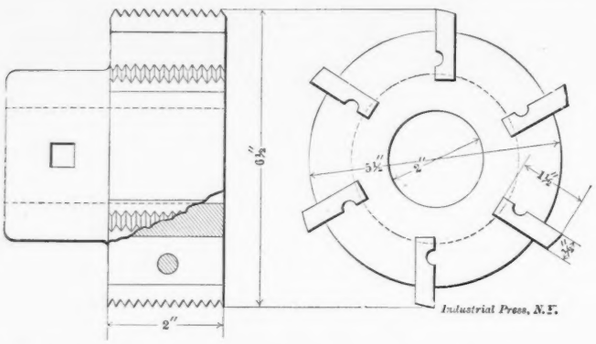
A. Putnam sends a sketch of a combination pipe and female center which, when carefully made and hardened, will be found very useful for a much wider range of work than is reached by the ordinary form of pipe center. It is turned at an angle of 60 degrees on the outside, for pipe use, while the point has a 90-degree female center for use with drills, as



illustrated. It should be a good fit at *A* and is cut away at *B* so that the bearing surface and consequently the friction on the tail center is reduced. A small hole is drilled completely through the end of the center to allow the air in the space *B* to escape when the fit at *A* is very snug.

A LARGE TAP WITH CAST-IRON BODY.

A. B. G. sends a sketch of a large tap which was made by casting tool steel blades into a cast-iron body. The blades, of which six were used, were grooved and drilled so that the iron could fasten to them more securely. They were finished all over and then passed through melted metal in order to warm them up before casting. When the castings were finished as required, they were heated all over, dipped, and the



temper drawn. One of these taps served for tapping over 200 valves and it could then be annealed, recut and hardened for further use. The taps were used in a lathe on a boring bar to which they were fastened by a square key passed through the shank of the tap. A few dimensions are given on the sketch to show the size of the cutters and the general proportions of the tap.

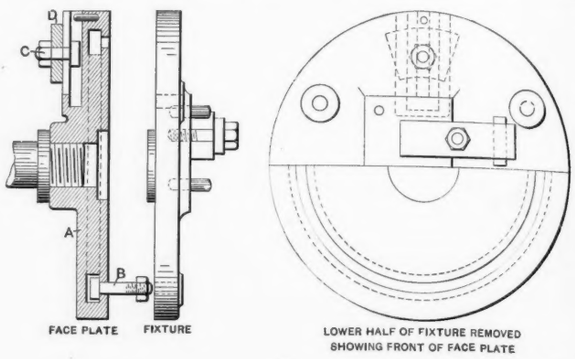
REMOVING SHAFTS FROM BABBITTED BOXES.

Regarding this subject N. G. B. writes: I have noticed in several repair shops the methods used when babbitting solid boxes and in most cases I note that trouble is experienced in removing the shaft, as it often sticks very tight. Machinists hold various opinions as to the best remedy for this trouble; some advise wrapping a piece of oiled writing paper around the shaft, others advocate the use of oil, and still others believe that the shaft should be smoked.

It happened the other day that we had several pulleys to babbitt on a 1¼-inch shaft. On one of these we tried the oiled paper and it was necessary to use a hammer to remove the shaft. On the second the shaft was simply oiled and still it stuck. The third shaft was smoked and this likewise stuck. We also had two boxes to be babbitted and on the shafts for these we used white lead. These shafts almost fell out from the box. While this "kink" may not be new to all of the readers of MACHINERY, there are doubtless many who will find the use of white lead of considerable assistance when they have work of this kind to do.

A FACEPLATE FOR USE WITH CHUCKING FIXTURES.

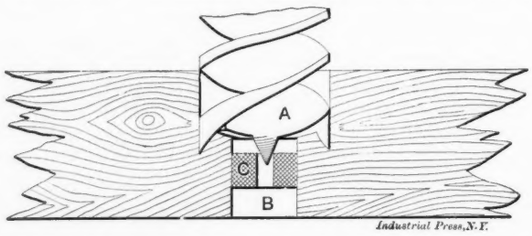
The accompanying sketch, sent us by R. E. F., illustrates a means for centering chucking fixtures accurately, and balancing them to prevent the vibration which results when large, lopsided masses of iron are revolved rapidly. The faceplate, *A*, is screwed onto the spindle in the usual manner and the fixtures are all made with a uniform base, and have three holes for the clamp bolts, *B*, and an accurately turned boss which enters a corresponding counterbore in the faceplate. On the back of the faceplate is a radial T-slot which



holds the square headed bolt, *C*, and secures in place a counterweight, *D*. At the end of the slot is placed a stop-pin to guard against an accidental discharge of the counterweight by centrifugal force. The clamping bolts, *B*, are held in the faceplate by a circular slot so that the fixture may be revolved in relation to the faceplate and, with the provision shown for adjusting the counterweight, the whole rig, with work in place, may be balanced to run without perceptible vibration. Several sizes of counterweights are provided so that pieces of widely varying weights may be counterbalanced.

COUNTERBORING HOLES FOR PATTERN WORK.

"Patternmaker" writes that the following "kink" often comes very handy to him when he finds it necessary to counterbore a hole in a pattern. Under ordinary circumstances the large hole *A* would naturally be bored first and then in the bottom of this would be drilled the smaller hole *B*. It is not, however, always practical to do the work in this order, so if the small hole *B* has been drilled first, and it is then necessary to counterbore the hole *A*, it is accomplished



with the assistance of the small lead disk shown at *C*. A liberal assortment of different sizes of these disks is kept in the tool chest and even if one of the exact size is not at hand the softness of the metal readily permits one of a larger size to be shaved down with little trouble. This disk fills the small hole and affords a center for the screw of the drill which is thus led concentric with the hole first drilled. This is a much more satisfactory as well as quicker way of doing this work than the ordinary method of driving a temporary plug in the small hole.

* * *

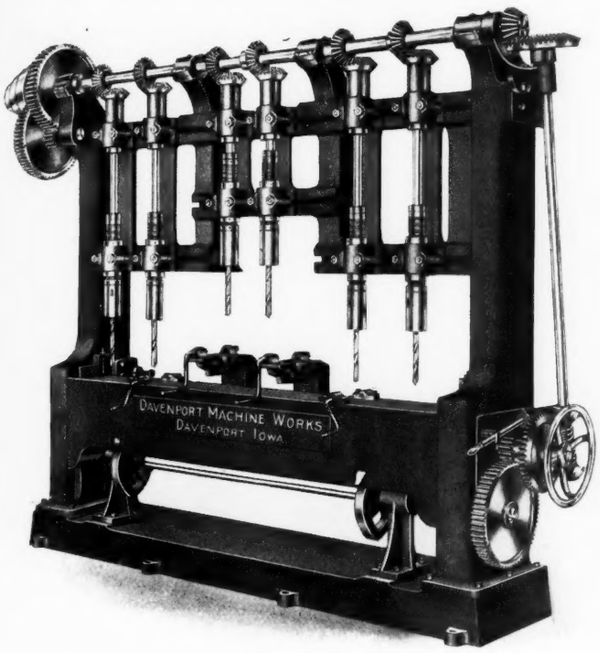
Working on the principle that if a power hack-saw having one saw is a good thing, a machine having two oppositely disposed saws will be twice as good, a British firm has brought out a power hack-saw for sawing I-beams in which two saw frames stand in a vertical position and attack the beam from opposite sides at the same time. It is said that the machine will cut through a 12 x 5 inch steel girder in 20 minutes, and that the opposite saw cuts will not deviate more than 1-32 inch at the meeting point.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

A NEW ARCH-BAR DRILL.

The Davenport Machine Works, Davenport, Iowa, have just brought out the new arch-bar drill which is illustrated in the photograph herewith. This machine, as shown, carries six spindles but it may be arranged for carrying eight if required. The crown of the arch-bar being drilled is held in a double support while the ends rest directly upon the table of the machine. The spindles have lateral adjustment for change of centers, and each spindle can be adjusted vertically to allow the use of drills of different lengths. The table, with the work, is fed up to the drills by means of two cams,



Davenport Arch-bar Drill.

one under each end of the table, which are driven by worm and spur gearing from the driving shaft. The table, which is counterbalanced, may also be raised or lowered by hand.

The drills are driven from a main shaft which is strongly back-geared to a three-step cone pulley carrying a four-inch belt. An automatic stop and quick return for the table also are provided. The width of the machine between housings is 7 feet and 4 inches, and it has a capacity for operating, at one time, six 1 15-16-inch drills with a feed of 1-64 inch per revolution of the drill. The weight complete with countershaft is about 12,500 pounds.

NEW UNIVERSAL AND TOOL GRINDING MACHINE.

The accompanying photographs illustrate a new grinding machine that has just been placed upon the market by the Brown & Sharpe Mfg. Co., Providence, R. I. As the name implies, this machine partakes in its nature, both of the universal grinder and the tool grinder, being designed to meet the requirements of the tool room for grinding milling cutters, formed cutters, beveled cutters of any angle, straight and taper reamers, etc., and also adapted to cylindrical grinding, either straight or taper. It is especially adapted to the needs of shops where the volume of work does not warrant the installation of different grinding machines to accommodate the variety of work that can be ground upon this machine. The arrangement of the various parts of the machine has been made with a view to facility of manipulation, simplicity and ease of access.

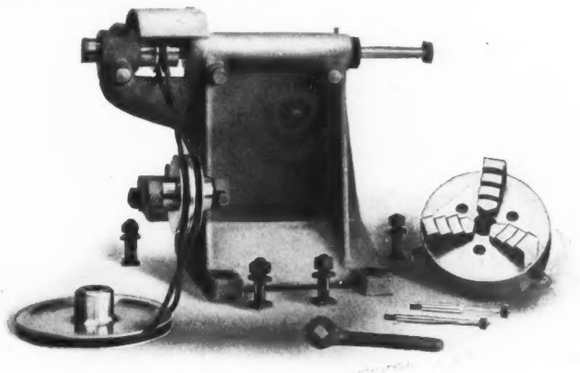
The grinder is provided with a swivel table which turns on a central stud and can be set to 45 degrees either side of the center line. Fine movement of this table is obtained by means of a thumbscrew adjustment. The table has an automatic longitudinal feed of 17 inches which is regulated by dogs that are provided with screws for fine adjustment. There are four changes of table feed, ranging from 6.7 to 40 inches per minute. A hand wheel is also provided for hand feed of the table, coarse or fine feed being obtained by a movement of the lever which controls both hand and power feeds.

The headstock and footstock have No. 3 taper holes and permit carrying work between the centers up to 8 inches in diameter by 24½ inches in length. The head spindle has both tight and loose driving pulleys and the front end is threaded to receive a chuck or faceplate. The footstock

Brown & Sharpe Universal and Tool Grinding Machine.

spindle can be adjusted longitudinally and has a fine adjustment by means of thumbscrews.

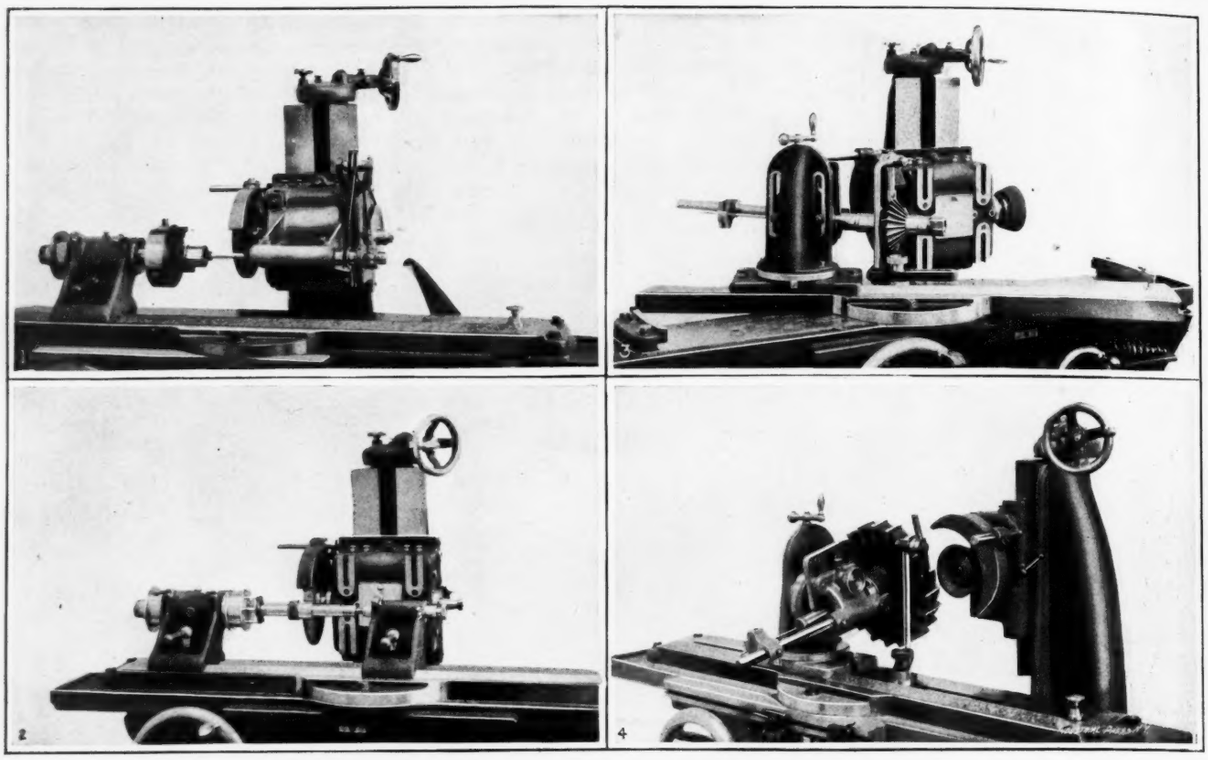
The headstock and footstock may be replaced by the universal head, shown on the floor at the left of the machine, for holding all forms of milling cutters directly by the shank or arbors, also for holding cutter bars to receive work mounted



Internal Grinding Attachment.

on sliding shells. The headstock sleeve and pulley can be removed and placed in the universal head, for grinding work that is larger in diameter than can be swung on the centers. The base is graduated to degrees around its circumference and the tool head swivels to 90 degrees either side of zero. The tool head has a vertical hand adjustment of 4 inches and at its extreme height will swing 16 inches in diameter over the table.

The cross feed is operated by a hand wheel graduated to read in thousandths of an inch on the diameter of the work. Both ends of the spindle are tapered to receive wheel sleeves upon which the wheels are mounted. The spindle is carried in a slide which has a vertical adjustment upon the slide upright, the movement being made by a handwheel that is graduated in thousandths of an inch. The upright has a transverse movement of 10½ inches and is operated by the cross feed hand wheel above referred to. It swivels on its base which is graduated to read to 90 degrees on either side of the center line.



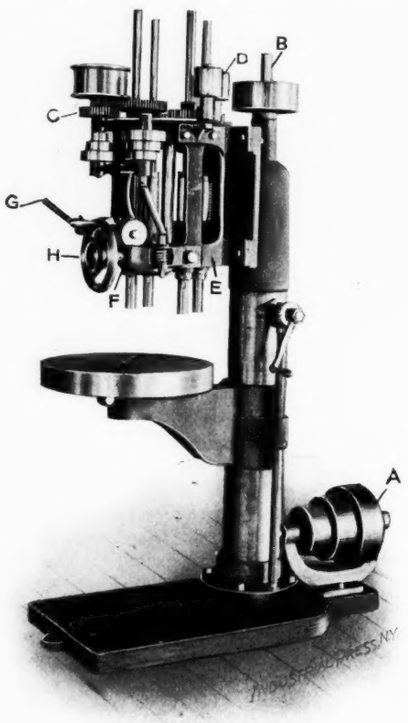
Some of the Applications of the Brown & Sharpe Universal and Tool Grinding Machine.

Numerous attachments are provided for increasing the scope of the work that this machine can accomplish. The internal grinding attachment on preceding page is made for grinding holes, either straight or tapering, from ¼ inch in diameter upward, and to 2¾ inches in depth. When in use this attachment is clamped to the front of the wheel slide by four bolts fitting in T-slots. The spindle is driven by means of a round belt running on a grooved wheel, that is placed on the right hand end of the main spindle. A circular grinding attachment is provided for grinding concave or convex cutters and work of a similar character, and a surface grinding attachment affords a means for grinding flat surfaces. This latter attachment comprises a wheel spindle extension, table plate and vise.

The group of photographs illustrates a few of the uses to which this grinder may be applied. Fig. 1 shows the internal grinding attachment employed for grinding a hole in a bushing. The bushing is held in a universal chuck mounted on the headstock spindle and revolved by the live center pulley. Fig. 2 shows the method employed for grinding the exterior surface of the same bushing, which in this case is held on an arbor revolving on dead centers. Fig. 3 illustrates the grinding of a double angle cutter, which is mounted on an arbor supported in the tool rest of the universal head. By swiveling the table, both angles can be ground without resetting the cutter. In Fig. 4 is shown a face milling cutter, held in the universal head, the teeth being ground on the sides by using a dish wheel. It will be noted that the tool holder is tipped at an angle to give proper clearance, and that the spindle slide upright has been turned through an angle of 90 degrees so as to present the end of the spindle to the work.

A MULTIPLE SPINDLE TURRET DRILL.

The accompanying half-tone illustrates a new turret drill, designed by Mr. S. A. Baker, and recently placed upon the market by the National Separator and Machine Co., Manchester, N. H. This machine is for drilling, tapping, reaming, etc., on duplicate parts without the necessity of changing the tool or the work. It is shown in the photograph as carrying four spindles but can be furnished, by the builders,

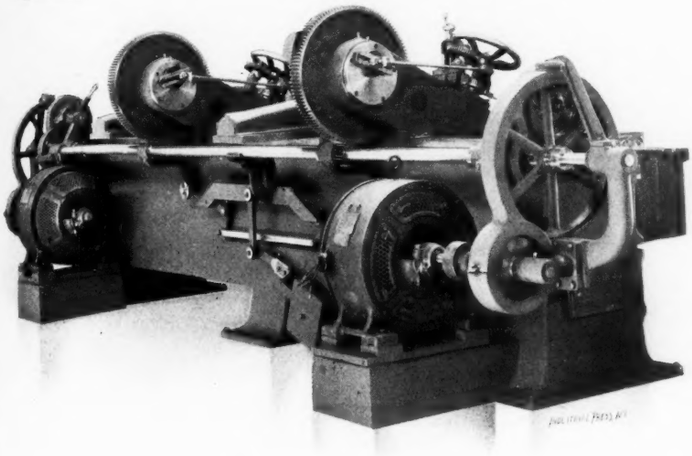


Four-spindle Turret Drill.

with three, four, five, or six spindles, as desired, and with either power or lever feed. It is driven, from the countershaft, by the three-step cone *A* which operates the shaft *B*

by bevel gears. This shaft connects with the driving gear *C* by means of a belt which passes around the idler pulleys *D*. The turret carrying the spindle revolves in the casing *E* and is arranged so that when the desired spindle is turned to the front, the driving gear connects with that on the spindle and causes it to revolve while the other spindles are left back out of the way until they are to be used, when the turret is revolved to each spindle in its turn. It will be seen in the photograph that the same size gear is placed on all of the spindles but one and this is geared down to a slow speed for tapping and counterboring.

The spindle is fed down to the work by the worm and worm-wheel *F* and is arranged so that it can be moved down directly and quickly by the lever *G*, also by the handwheel in front, and by power by simply tightening the knob *H*. The spindles can all be set to stops and are counterbalanced. All of the tools work to the same point on the table and only one spindle, the working one, is revolving at a time. The locking pin is directly beside the spindle that is in use, and the moment power is applied the strain passes to the frame of the machine, the turret acting simply as a guide to the spindle.



Cincinnati Traverse Shaper with Electric Drive

ELECTRICALLY-DRIVEN DOUBLE HEAD TRAVERSE SHAPER.

The double head traverse shaper shown herewith has recently been supplied to the Locomotive & Machine Co., Montreal, Canada, by the Cincinnati Shaper Co., Cincinnati, Ohio. This machine is operated by two Westinghouse motors, which are arranged for the 2-voltage, 3-wire system and rated at 3 and 6 horse power at 115 and 230 volts respectively. The variation of speed of the machine is obtained through the variation of the motor, and also by back gearing on the machine, as may be seen through the large gear wheel on one of the two splined shafts at the back. This large gear wheel is driven by a pinion mounted on the motor shaft.

The two heads are driven independently, one from each end of the machine and as they are arranged to work at any point along the bed it is necessary that they travel past the center of the bed. Owing to the length of the splined driving shafts by which the heads are driven it has been thought best to provide a support at the center of the bed and the photograph shows the arrangement that has been made for automatically depressing this support when one or the other of the heads is passing the center of the bed. As stated, each head is driven independently by a full length driving shaft and the feeds to each saddle are also operated by independent full length screws. The travel of each saddle is 118 inches, the maximum distance between the tools 144 inches, and the minimum 26 inches. The total weight of the machine is about 14,000 pounds.

VARIABLE SPEED MOTOR DRIVE FOR PLANERS.

The half-tones, Figs. 1 and 2, illustrate a new motor-driven planer, built by the Cincinnati Planer Co., Cincinnati, Ohio, which is designed to give a variable speed to the cutting stroke and a constant return stroke at all times. It is adapted to the use of a standard constant speed motor which is

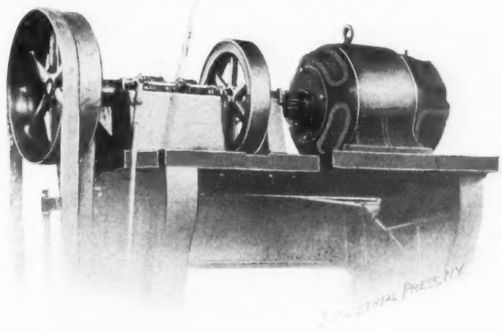


Fig. 1. Rear View of Variable Speed Planer Drive.

mounted upon the top of the housings and from which the power is transmitted to the rear, or constant speed shaft, by a pair of spur gears, one of which is of rawhide to obviate any noise. This first or constant speed shaft carries the return shaft and consequently always gives the table the same speed for the return stroke. Upon this shaft is also mounted a heavy flywheel, to relieve the strain on the motor at the reverse.

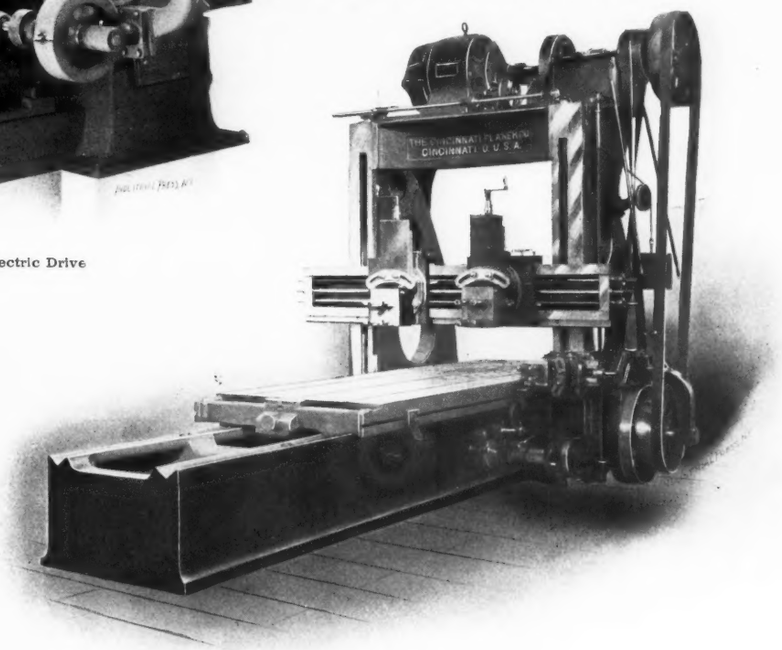


Fig. 2. Cincinnati Planer with Variable Speed Motor Drive.

The pulley for the cutting stroke is placed on a separate, or forward shaft, as shown in the front view, Fig. 2, and to it power is transmitted from the constant speed shaft by two trains of gearing, each giving two speeds, which consequently makes four cutting speeds available for driving the platen. The changes in speed are obtained by simply moving one or both of the levers shown on the side of the planer, and they may be made either while the machine is in operation or while it is standing idle.

The cuts illustrate this drive as applied to a 48 x 48-inch planer, but the builders state that the same style of drive has been applied to all the other sizes of planers which they manufacture. The speeds used on this machine were arranged for cutting at 20, 25, 30 and 36 feet per minute, with a constant return speed of 72 feet per minute.

HORIZONTAL BORING, DRILLING AND MILLING MACHINE

The Fosdick Machine Tool Company, Cincinnati, Ohio, have just placed upon the market the machine illustrated in Figs. 1 and 2, which is designed for both light and heavy boring, drilling, tapping, reaming, facing and milling, all of which operations are performed upon the work which is fastened to the table. The accompanying half-tone gives a view of the machine as seen from the operating side, while the line-drawing, Fig. 2, shows an end view and illustrates many of the details of construction.

The machine is driven by a splined shaft, which traverses the driving cone on the rear of the bed. The column, carrying the spindle head, has a horizontal movement on the bed, by hand or power, and a quick forward and return motion by

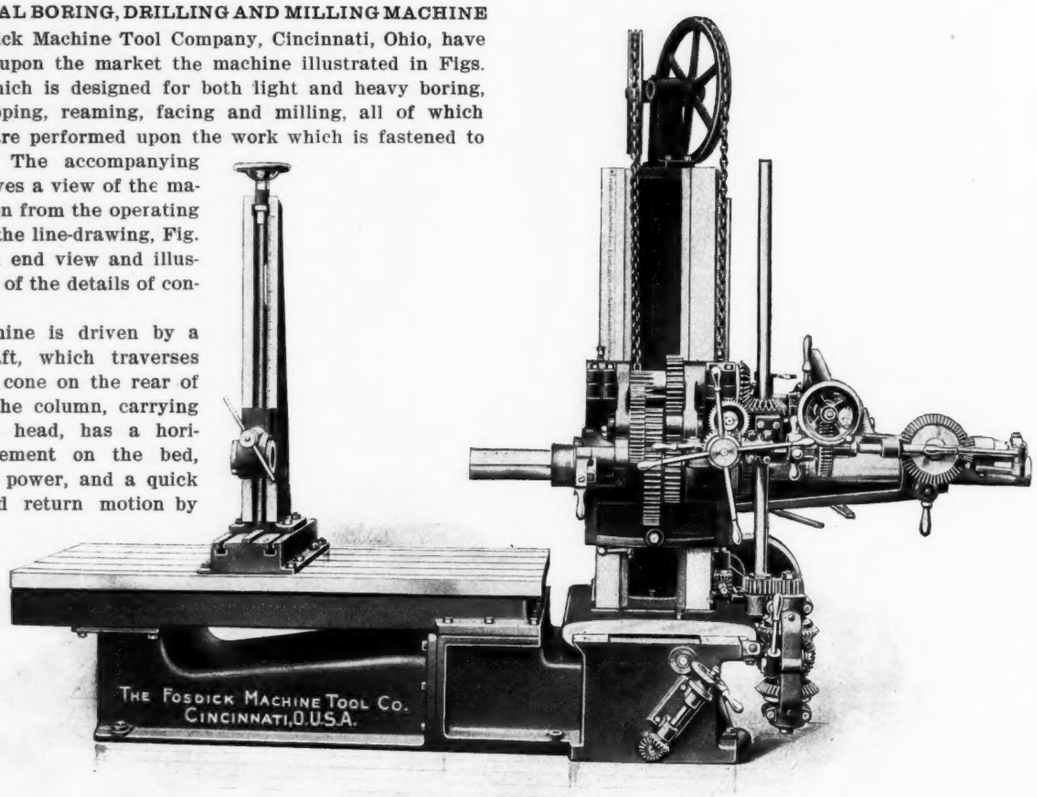


Fig. 1. Fosdick Horizontal Boring, Drilling and Milling Machine.

power which is operated by a handwheel on the front of the bed. The spindle head is counterbalanced and provided with a safety chain. It has a movement on the column by hand or power, and for quick adjustment is operated through a rack and pinion by means of a pilot wheel on the front of the spindle head. The spindle runs in adjustable box bearings, and has a thread cut on its front part to receive chucks, large milling cutters, facing heads, etc. It is made to revolve in a right or left hand direction by the operation of a reversing lever. This is very convenient for facing, tapping or milling operations.

The spindle bar, which passes through the spindle, is 4 inches in diameter, has a traverse of 22 inches, and is fitted to receive drills, taps, reamers, etc. It has power and hand feed in both directions, is operated by pilot wheel for quick adjustment, and can be securely clamped when in use for face-milling purposes. The back gears are located on the spindle head, and are operated by a lever conveniently located, by which they may be engaged or disengaged while the machine is in operation. The outer support for the boring bar can be clamped securely to the table, has horizontal and vertical adjustment, and is provided with graduated steel rules, as are also the face of the column and the bed. The table in which the T-slots are planed, is stationary and securely bolted to both the bed and the base.

All the feeds, the horizontal feed of the column, horizontal feed of the spindle bar, and vertical feed of the spindle head, are taken from the spindle, are positive geared, and are operated by hand or power. These feeds are eight in number, and arranged in geometrical progression from .007 to ¼ inch per revolution of spindle; they are all reversible. The spindle speeds are ten in number, arranged in geometrical progression from 4 to 260 revolutions per minute. The total height of this machine is 8 feet and the length, over all, 10 feet 6 inches. The net weight is 12,000 pounds.

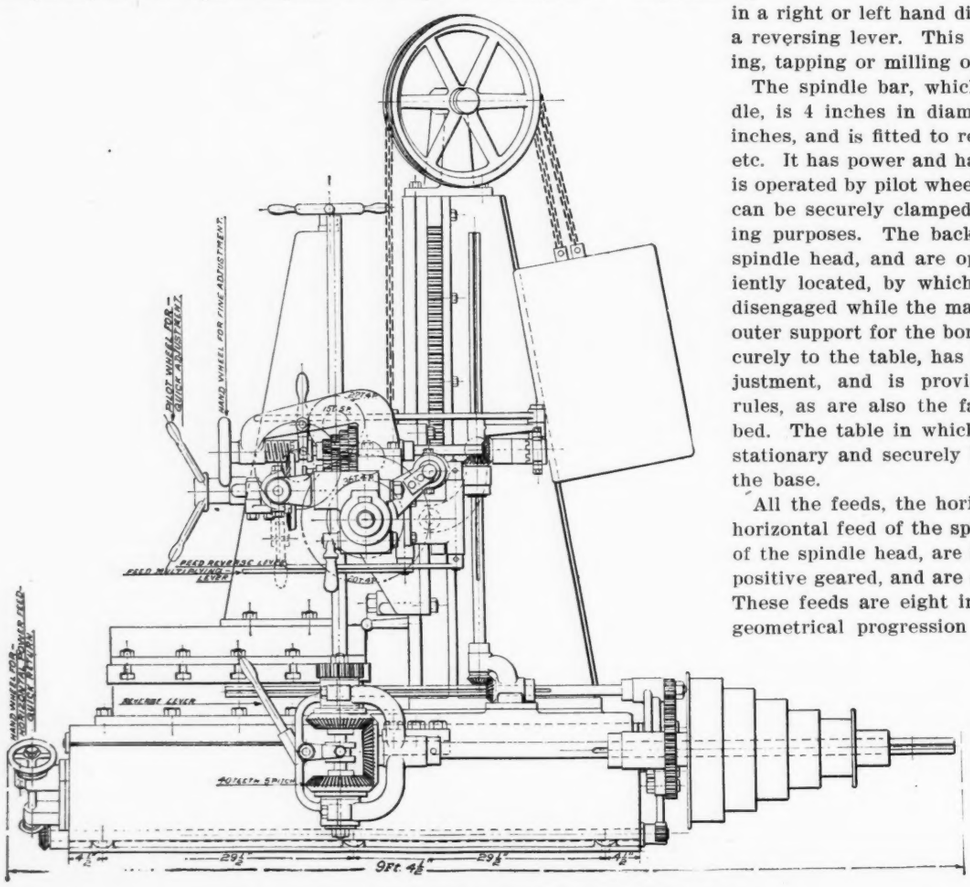


Fig. 2. End View of Horizontal Boring, Drilling and Milling Machine.

THE "QUEEN CITY" SHAPER.

The 16-inch crank shaper illustrated in Fig. 1 is especially designed for use with the high-grade tool steels and is furnished by the builders either with or without back gearing. The back gearing, when employed, is wholly enclosed within the column and is operated by a lever at the back. Fig. 2 shows a line drawing of this mechanism, and also shows the different trains of gears that are used for driving the bull wheel. The ram is of special construction, so designed as to lose none of its rigidity throughout the stroke. The connection of the rocker arm to the ram is of the link type, giving a straight pull on the cutting stroke and a quick return. The arm is provided with an adjustment to compensate for wear of the crank shoe.

The rail has unusually wide bearings on both top and bottom, and the adjusting gibs between the ram and the rail are firmly held by screws fitted with nuts flush with the casting. The head may be swiveled, over a graduated disk, to any required angle, and the down-feed screw is provided with a graduated collar indicating thousandths of an inch. The horizontal traverse screw is also provided with a similar collar. The table is of box form, having T-slots on top and side, and a *V* for holding shafts or similar work vertically. It can be readily detached from the apron. The vise has a graduated circular base, allowing it to be set at any angle, and it may be attached to the top or side of the table. An opening is provided under the ram so that shafts or pieces of any length similar may be passed through for key-seating. The length of the stroke can be quickly changed and locked from the working side without stopping the machine. The shaper is the product of the Queen City Machine Tool Company, Cincinnati, Ohio.

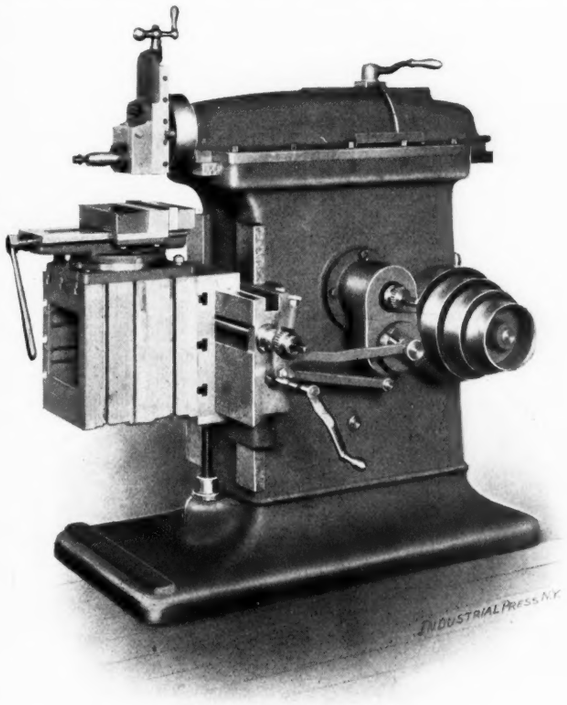


Fig. 1. "Queen City" Crank Shaper.

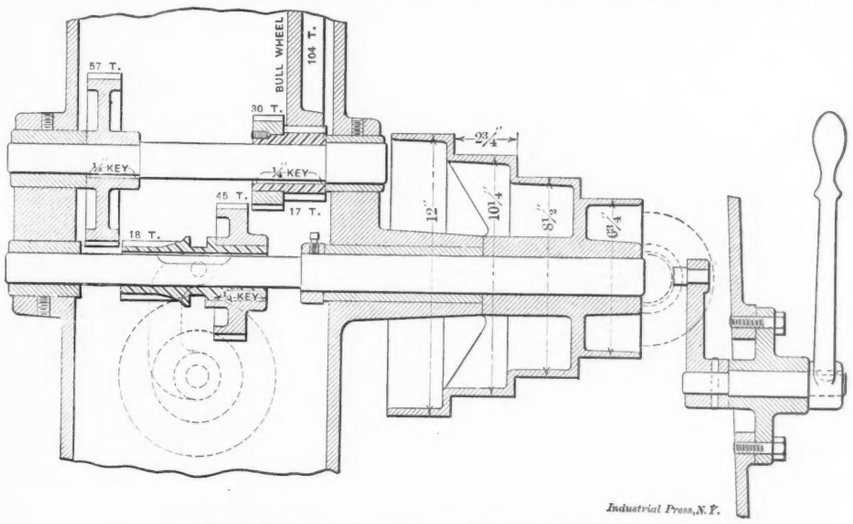


Fig. 2. Back Gear Arrangement of "Queen City" Shaper.

NEW LATHE WITH ALL-GEARED HEADSTOCK.

The American Tool Works Company, Cincinnati, Ohio, have just brought out a new lathe, with all-geared headstock forming a unit to which any type of electric motor may be readily connected. The motor may be placed on the top or at the rear of the gear-casing. The changes of speed are produced by an arrangement of six gears, oppositely disposed on the spindle and driving shaft, which are engaged by means of levers placed in front of the speed box. In connection with a variable speed motor, on a 20-inch lathe, this mechanism provides for sixty spindle speeds, ranging from 5 to 322 revolutions per minute. The lever for the control of the motor is placed on the right-hand side of the carriage.

This same speed-changing mechanism is also adapted for belt drive, and will permit of a machine thus installed being converted into a motor-driven tool at any future time. In addition to the speed variator, the lathe is equipped with a rapid-change gear mechanism providing a wide range of changes for feeding and screw cutting, each change being available while the machine is in operation and without the removal of a single gear. The leadscrew is placed on the inside of the bed so that the pull on the carriage is directly under the cutting tool, and the half-nuts by which the screw is engaged and released are operated by a lever at the front of the carriage.

A NEW BENCH SHAPER.

A new crank shaper that is especially adapted to tool room and bench work has just been placed upon the market by L. E. Rhodes, Hartford, Conn. Taking into consideration that a large percentage of shaper work is small and of a light nature, coming well within the range of 7 inches, this length of stroke has been selected. The greatest distance from the table to the ram is also 7 inches. The driving arm reaches well into the interior of the ram and is connected by a link which is located at a point in a direct line with the greatest resistance of the cutting tool. The shaper is provided with ratchet cross feed and both cross and down feed screws have micrometer adjustment. The table is of box pattern, provided with a vise having quickly adjustable jaws and a swivel base graduated in degrees. Upon the driving shaft is mounted a three-step cone and also a handwheel. Although designed for a bench machine, it may be supplied mounted upon an iron stand if desired. It occupies a floor space of 22 x 24 inches, and weighs, with the countershaft, 290 pounds.

VERTICAL BORING, FACING, AND TAPPING MACHINES.

Figs. 1 and 2, next page, show two types of boring, facing and tapping machines that are the product of Baker Bros., Toledo, Ohio, and are designed for the heaviest kind of work in locomotive shops and shops manufacturing large steam fittings. The main spindle is driven by means of a cross arm in the housing shown on top of the driving gear. This arm is about three times the diameter of the spindle in length and is provided with broad bearing surfaces, which work in vertical grooves on either side of the housing. This construction avoids the excessive friction that is occasioned

by the usual method of driving by means of a feather in the hub of the driving gear. The thrust of the spindle is taken on roller bearings.

The entire train of gearing employed is very heavy, the main driving gear being 28 inches in diameter by a 4-inch face, and 2 pitch. Triple back-gears are provided giving, with four steps on the cone pulley, twelve changes of speed. The ratio of gearing with the triple back-gears is 1 to 82. The twelve spindle speeds range from 2 to 45 revolutions per minute, and

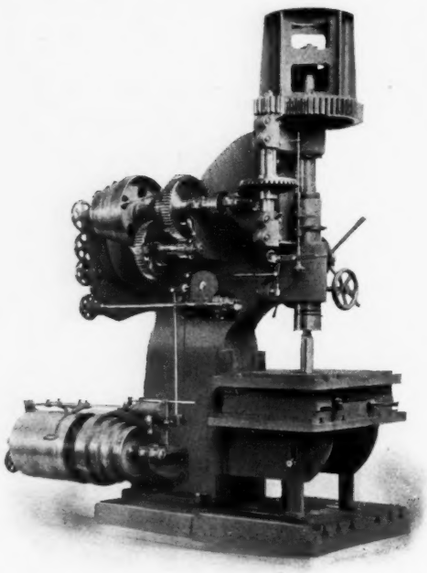


Fig. 1. Single Vertical Boring, Facing and Tapping Machine.

for each spindle speed there are six belt-driven feeds, varying from 0.54 to .003 inch per revolution of the spindle. In addition to the belt feeds the machine is provided with a positive geared feed which, by means of change gears, will give any feed from .07 to ¼ inch. These are arranged so that a positive lead corresponding to any number of threads from 4 to 14 may be obtained for tapping. The spindle, which may be made with either 14 or 20 inch travel, is provided in addition to the belt geared feeds above-mentioned, with lever feed, hand-worm feed, an automatic stop, and is counterbalanced.

The machine is furnished with a compound table, 30x36 inches, which is placed under the regular table and is very handy for use in chucking work, as the piece may be clamped approximately in position and then, by means of the table screws, brought into line with the spindle or boring bar. This table has a right-and-left adjustment of 20 inches, and an in-and-out adjustment of 14 inches, and with it the machine may often be used to advantage for milling.

Fig. 2 shows a combination of two of these machines upon a single base, each spindle being driven by a 10 horse power General electric motor, by means of a Renold silent chain. The ratio of the gearing to the spindle is 175 to 1 and triple back-gears are employed which, being again compounded, give six changes of speed, varying from 3½ to 43 revolutions per minute. Intermediate speeds are obtained by means of speed control. There are twelve changes of feed positively driven by Renold silent chain and ranging from .1 to .005 inch per revolution of the spindle. Both frames are adjustable along the base, to vary the center distance, and the left-hand frame may be moved by power.

NEW 17-INCH LATHE WITH TURRET ATTACHMENT.

Greaves Klusman & Co., Cincinnati, Ohio, have entirely redesigned their 17-inch engine lathe and are placing it upon the market fitted with power feed automatic turret. In addition to the feeds of this turret, which are obtained by the usual cone pulleys, it has three changes of feed on the front side of the turret where they are directly under control of the operator by means of a lever placed near the pilot wheel. The lathe is provided with a five-step cone pulley for 2½ inch belt, and is strongly back geared. All feeds are reversed at the apron and arrangement is made for preventing the engagement of feed rod and leadscrew at the same time. The cross and longitudinal feeds, however, may be operated simultaneously. Provision is made for cutting threads from 2 to 48 per inch, including the 11½ pipe thread, without change of spindle gear, the change from right- to left-hand thread being made by a reversing lever at the headstock. There are four changes of belt feed, and gear feed is also provided, so that all feeds needed can be obtained with the feed rod, reserving the leadscrew solely for thread cutting. The countershaft has friction pulleys with a special arrangement for oiling without throwing off the belt.

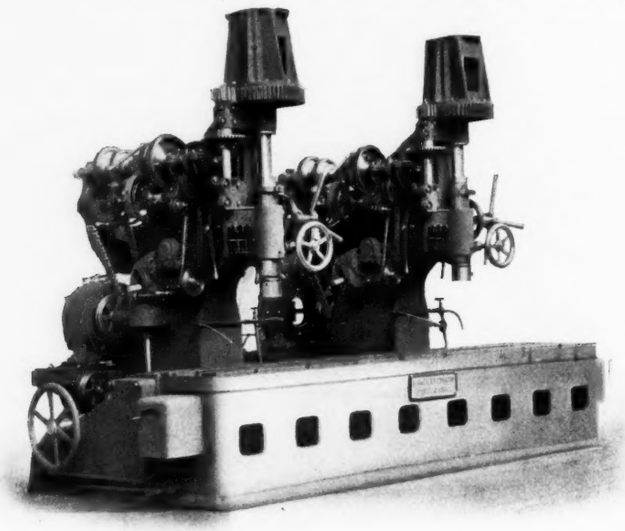
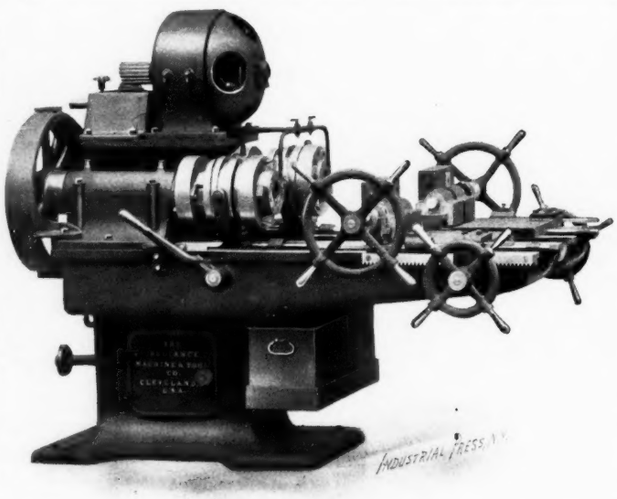


Fig. 2. Duplex Vertical Boring, Facing and Tapping Machine.

A DUPLEX MOTOR-DRIVEN BOLT-CUTTER.

The accompanying half-tone illustrates a 2-inch double bolt cutter, with motor drive, that has just been brought out by the Reliance Machine and Tool Company, Cleveland, Ohio. This is the same as their standard machine, with the exception that the belt pulley is replaced by a motor, which is placed between and above the headstocks, where it is free from oil and chips and occupies no valuable floor space. A 3 horse power Crocker-Wheeler reversible, variable-speed motor is



Two-inch Duplex Motor-driven Bolt Cutter.

used, giving a speed variation of 3 to 8. A nest of gears placed between the pinion on the motor shaft and the main pinion of the machine increases this ratio to 1 to 6. By means of a Cutler-Hammer speed controller used in connection with the motor, eighteen spindle speeds are obtained. While this arrangement has proved so satisfactory as to be adopted as the standard drive for this machine, the builders inform us that they are prepared to furnish any other electrical equipment that may be desired, and connect the same either by direct gearing, belt or silent chain.

PORTABLE ELECTRIC "SCOTCH" DRILL.

The portable, electrically-driven "Scotch" drill, illustrated herewith, is being placed on the market by the Hisey-Wolf Machine Co., Cincinnati, Ohio. This machine has a capacity for carrying drills up to ⅞ inch in diameter and has a feed of 7 inches by the handwheel. The adjustable bracket upon which the drill is mounted has a movement of 20 inches in any direction, making the machine universal. The drill has two speeds, the power being obtained from any incandescent lamp circuit where direct current is employed, the motor being wound for 110 and 220 volts. The motor is inclosed and dust proof and is suitably geared to develop the necessary power up to the capacity of the drill. The machine may be carried from point to point around the shop, its sphere of action being limited only by the length of the flexible wire connection. Its weight is 95 pounds and extreme height 30 inches over all.

TWELVE-INCH ELECTRIC-DRIVEN SENSITIVE DRILL.

A novel and very practical application of the electric motor for machine tool operation is illustrated by the 12-inch sensitive drill shown in the accompanying photograph. In this machine the motor is mounted upon the frame directly over the spindle and has a hollow shaft through which the spindle slides and is driven by a key. By this arrangement the power is applied directly to the spindle and none is wasted in belts, gears or friction wheels. The spindle has but three bearings, and as there is no side pull from belts or gears the wear is reduced to a minimum. Four speeds are provided, ranging from 500 to 1,500 revolutions per minute, all obtained by simply moving the starting handle, shown on the side of the motor, to different positions, which are clearly marked, to show the speed at each point. A higher range of speed may be provided for, if required. This drill is designed and built by James F. Willey, Jeffersonville, Ind., and is being placed upon the market by Jas. Clark, Jr., & Co., Louisville, Kentucky.

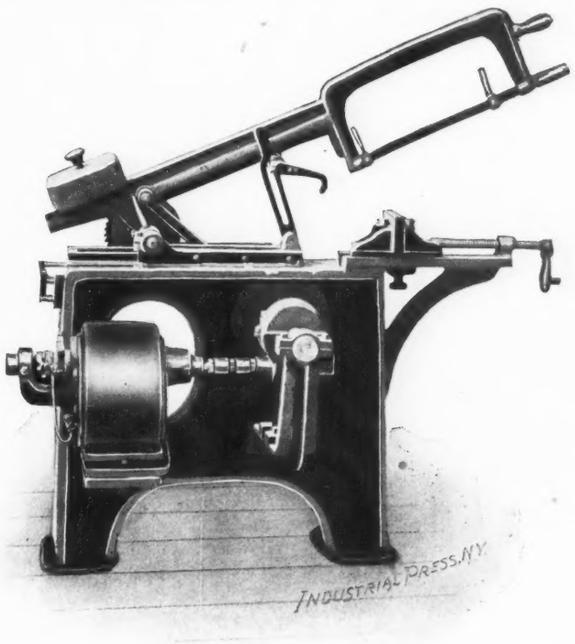
Portable Electric Drill.

Sensitive Electric Drill.

MOTOR-DRIVEN HACK SAW.

The Patterson Tool and Supply Co., Dayton, Ohio, are equipping their "Challenge" power hack saws with motor drive, as illustrated in the accompanying cut, so that they may be used in stores or stock rooms where belt driving power is not available. The motor by which this saw is driven is made by the Sterling Electric Co., Dayton, Ohio, and is especially wound so that the usual rheostat or starting box is dispensed with, a knife blade switch on the back of the machine frame being used for starting or stopping. This switch is automatically thrown out at the end of the cutting. The motor is usually wound so that it may be connected with the ordinary electric light current and the saw operated through a worm and worm gear, but a slow speed motor and belt drive may be furnished if desired.

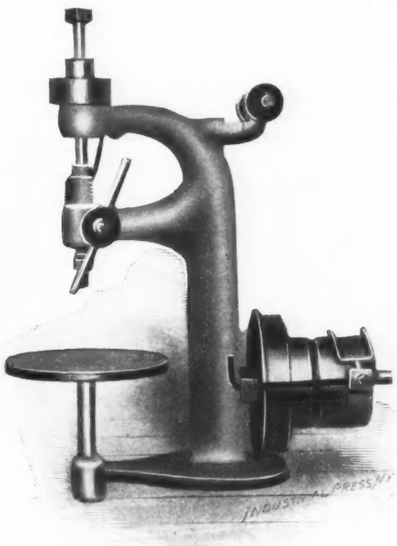
The saw has a capacity of 6 x 6 inches, and is fitted with a vise that is adjustable, forward and back, so that when one end of the saw is worn out the other end can be used. The friction arrangement, in connection with the sliding counterweight, gives a positive feed, but on the return stroke relieves the saw and prevents it from dragging over the work. The same machine may also be furnished with a pulley substituted for the motor and worm gearing and either type of saw can, when desired, be supplied with a raised arm, which makes it capable of cutting 12-inch I-beams, channels and similar work.



Electrically-driven Hack Saw.

NEW TEN-INCH BENCH DRILL.

The Miami Valley Machine Tool Co., Dayton, Ohio, have just brought out the bench drill illustrated in the accompanying photograph, which, although following quite closely the ordinary lines of design of such tools, has been built with especial attention to simplicity and rigidity of the parts.



Ten-inch Bench Drill.

The swing of the drill is 10 inches and it is provided with counterbalanced lever feed and a two-step driving cone. It is driven from the countershaft by tight and loose pulleys, having a belt shifter so located as to be readily accessible to the operator. The total weight of the drill is about 55 pounds.

AUTOMATIC HACK SAW.

The hack saw which is illustrated in the accompanying photograph is a full automatic machine which cuts up bars or pipes into pieces of uniform length without any attention other than starting it upon the first cut. On the completion of a cut the saw rises, vise opens, the work is fed forward the required length and the vise closed. Then the saw falls and a fresh cut is commenced. When the bar has been entirely

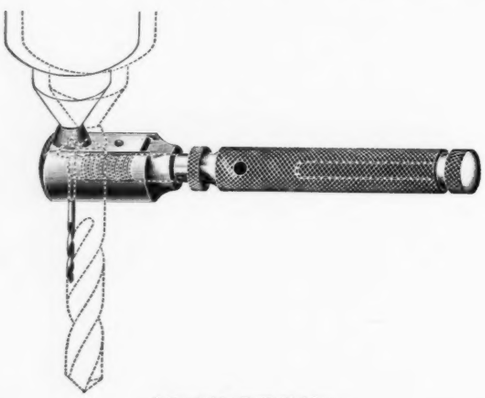
Automatic Hack Saw

cut up a bell rings continuously until the machine is attended to. If a saw blade breaks the bell also rings for attention. The machine can be set for single cuts when the bell rings on the completion of the cut.

No adjustment is required other than setting the gage for length, as with the ordinary saw. The length gage moves clear of the work while the cutting is in progress and so prevents the detached piece from jamming and breaking the saw. The counterbalance weight, by means of a simple mechanism, alters its position automatically to compensate for the blunting of the saw through use. The machine handles stock of any length and of any size and shape up to 4 inches. It is simple in construction so that it will not easily get out of order and may be operated by unskilled labor. It is being placed upon the market by Montgomery & Co., New York, N. Y.

A HOLDER FOR SMALL DRILLS.

The little device illustrated herewith will be appreciated by any one having to use small drills in connection with lathe work. Ordinarily, drills up to one-half inch are pointed on the back end and in order to use them in the lathe this point



Adjustable Drill Holder.

must be ground off and a female center made on them, or else they must be held in a drill chuck fitted to the tailstock spindle. With this device small drills may be used without any alteration whatever. It consists of a holder in which the drill is secured by a few turns of the handle, while on the back of the holder is a floating female center into the inner side of which the pointed end of the drill fits and thus locates the center exactly in line with the point of the drill. The female center is then used with the tailstock center in the same manner as when using large drills. With this holder the operator is at all times able to tell the exact tension to which the drill is subjected and breakages are largely avoided. Inserted in the end of the handle is a small bar which may be removed and used for tightening the drills, by placing it in a hole drilled at right angles with the handle. The cut shows how the holder is applied to the smallest size of drill, while the dotted lines illustrate its application to the largest drill within the capacity of the machine. At present this holder is made to use drills from No. 60 up to 5-16 inch, but larger sizes will be made later. It is the product of the O. K. Tool Holder Co., Shelton, Conn.

PORTABLE VISE STAND.

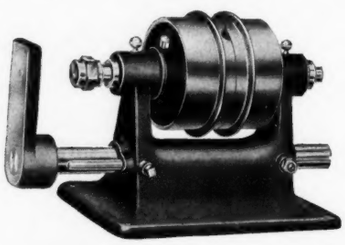
The Western Mfg. Co., Springfield, O., believing that it is sometimes the easier course to take the mountain to Mahomet, have just brought out a novelty in the way of a portable vise stand which is designed for moving around the shop to any place where it may be desired to do any filing or fitting. Thus, instead of having to carry piles of castings to a bench, the stand, which is in effect both bench and vise, is rolled to the

Portable Vise Stand.

pile of castings and as soon as that job is done it is rolled along to the next. The device consists of a cast-iron base and column, weighing about 225 pounds, and having mounted at the top a table 17 x 21 inches, and a regular machinist's vise which may be fitted with plain or combination pipe jaws. On two corners of the triangular base are placed wheels so that the whole device may be easily moved, while the third corner is formed into a substantial foot which prevents any movement of the device when it is in use.

TAPPING DEVICE FOR SMALL WORK.

The tapping device illustrated below has just been placed on the market by Blomquist & Welander Co., Cleveland, Ohio. The driving pulleys run on hollow studs, thereby relieving



Device for Tapping Small Holes.

the spindle from all pressure due to the belt and making it very sensitive to the tap. The spindle is driven by a steel clutch working between the pulleys which are operated by open and crossed belts, thus insuring instant reversion. The spindle is also provided with a spring clutch with a long taper to give a perfect grip to the tap. The tailstock is mounted on a round steel rod which slides in the frame and is adjustable to any length of work. This device has a capacity for tapping holes ranging from the smallest up to ¼ inch in diameter.

* * *

FRESH FROM THE PRESS.

In our review of the book, "Iron, Steel and Other Alloys," published by Sauveur & Whiting, Boston, Mass., we stated that the price was $8.00. It should have read $5.00.

GAS ENGINE TROUBLES AND REMEDIES, by Albert Stritmatter. Published by the Gas Engine Publishing Company, Goodall Bldg., Cincinnati, O. 112 12mo pages. Price $1.00.

The title of this book is an explanation of its contents, which consist of nine chapters, as follows: Gasoline feed supply; starting; fuel consumption; ignition; timing; two chapters on general troubles; lubrication; detecting trouble by sound. It is essentially a book on the care and operation of the gas engine, and will be found useful by those who have such engines in their care.

THE DRAFTING OF CAMS, by Louis Rouillon. Pamphlet published by the Derry-Collard Co., New York. Price 25 cents.

This is No. 2 of the single-copy series of practical papers published by this company—the first being on the subject of tapers, as previously noted in these columns. The matter on cams which is given in this pamphlet is, in part at least, made up from articles by Mr. Rouillon for MACHINERY, and it is a concise and practical treatise on the subject, showing methods of laying out cams of various kinds.

EMERY GRINDING MACHINERY, by R. B. Hodgson. Published by J. B. Hodgson, Birmingham, England. For sale by J. B. Lippincott, Philadelphia, Pa. 180 12mo pages. Illustrated. Price $2.00.

This volume, it seems to us, would be of very little value to any American mechanic. It is a compilation of information and descriptive matter very general in character, and does not contain anything like the amount of practical information to be found in various technical articles that have been contributed to American mechanical publications. While it would undoubtedly assist a novice to an understanding of grinding machinery and processes we doubt if the practical mechanic would derive much benefit from its perusal.

EXPERIMENTS ON THE FLEXURE OF BEAMS, by Albert E. Guy. Published by the D. Van Nostrand Company, New York. 122 12mo pages. Illustrated. Price, $1.25.

The most, or the whole, of the matter in this volume first appeared in the pages of the *American Machinist*. It consists of a treatise on the flexure of beams and columns by a new analytical method based upon experiments. Mr. Guy has undoubtedly discovered some laws connected with the problem that have previously escaped investigation, and his discussion will be found an interesting and valuable acquisition to the science of the strength of materials.

GAS ENGINE DESIGN, with an introduction on compressed air, by E. J. Stoddard. Published by Parker & Burton, Detroit, Mich. In large pamphlet form, 98 pages. Illustrated. Paper cover, 25 cents; cloth, $1.00.

The author states in a preface that the formulas in this work have received the approval of so many scientific men that he has presented it with confidence. The book has many drawings and consists of two parts—the first of which is a rather elaborate discussion of air when under compression or expansion, and the second relating particularly to proportions of the parts of gas engines. It discusses the dimensions of the cylinder to produce a given amount of power; the reciprocating parts; flywheel; valves; ignition apparatus, and general proportions. The treatment is mathematical—much more so than Roberts' well-known handbook.

Illustrated. Published by John Wiley & Son, New York. Price $1.50.

ELECTRICAL ENGINEERING. Translated from the German of E. Rosenberg, by W. W. H. Gee and Carl Kinzbrunner. 267 8vo pages.

This book had its origin in a number of lectures delivered to the workmen and engineering staff of a large electrical firm, and the author states that the class of readers for whom the book is intended is the same as that to whom he lectured. It is designed to give to workmen, draftsmen, students and others a knowledge of electrical machinery and apparatus, and a good general education is all that is required to understand the treatment. We believe this volume fills this field satisfactorily, although it must be remembered it is a foreign work, not dealing with American apparatus to any extent. It has one merit in particular—that of treating alternating-current machinery, which is seldom taken up in elementary books of this character. It of course takes up continuous-current machinery, including generators and motors, and discusses electric lighting, accumulators, alternators, working dynamos in parallel, and high-tension currents.

DESIGN OF A HIGH-SPEED STEAM ENGINE, by J. F. Klein, Professor of Mechanical Engineering at Lehigh University. Published by D. Van Nostrand Company, New York. 257 pages, profusely illustrated with diagrams and tables. Price, cloth, $5.00.

The first edition of this book was published with the intention of making it Part 1 of a treatise on the dynamics and design of a high-speed engine, second part being planned to treat of the dynamics and design of shaft governors. This second part, proving to be too voluminous to be suited for undergraduate work in technical schools, it was decided to issue the two works independently, and the present edition of engine design is, therefore, presented without reference to the work on shaft governors. Much new material has also been added to that contained in the first edition, in the form of appendices. The arrangement of the subject is in the form of a problem in engine design. Stating at the start the conditions that would be given to the designer, the order of calculation then presents a systematic arrangement of the steps to be followed in consummating the entire design, and the succeeding chapters of the book are devoted to the investigation of each step in the calculations in the order in which they are outlined. The treatment is especially suited to the student who wishes to investigate the theoretical conditions governing the design of high-speed engines; and the treatment, which is thorough and clear, is confined strictly to this class of engine work. Solutions of the various problems involved are presented both mathematically and graphically. The chapters devoted to the subject of valve diagrams are unusually complete and are illustrated by numerous diagrams of the leading types of both single and double valves. In the appendix is a treatment of the subjects of the inertia resistance of the rod, determination of pin pressures and a chapter upon the subject of link motions including Stephenson's, Gooch's, and Allan's.

A HANDBOOK ON THE STEAM ENGINE. By Herman Haeder, and translated from the German by H. H. P. Powles, with additions and alterations. 458 pages, 1,085 cuts, and about 180 tables. Published by Crosby, Lockwood & Son, London; and D. Van Nostrand, New York. Price, $3.

That this book has proved to be quite a valuable one is indicated by the fact that the copy sent for review is of the third English edition. It is a work that should be appreciated by many mechanical engineers, designers, and draftsmen, especially those who care for European practice, as, with much other data, it gives a large number of tables of dimensions of Continental and English steam engines. The theoretical part has been treated briefly, and where formulas are necessary they are given, but are not intruded where there is no need for them. Following the historical notes the first section takes up the types of engines, giving outline diagrams showing arrangement of frames and cylinders; then follows the section on details, covering 118 pages. The section on governors is not so complete as it should be to attract the designers of American high-speed steam engines, but this is in a measure compensated for by the chapter on valve gears which gives in concise terms a great deal of matter regarding the leading types. The following sections are: Condensers, Air-pumps, and Feed-pumps; Examples of Engines of Continental Make from Actual Practice; Particulars of Engines by English Makers; Compound Engines; Indicators and Indicator Diagrams; Calculations for Power and Steam Consumption; Effect of Inertia on Reciprocating Parts; Boilers, etc. While a book of this nature always contains considerable obsolete matter and is necessarily behind the most advance engineering practice—a condition, by the way, that attaches to all engineering literature—it is, we consider, a good work for the library of the mechanical engineer and designer who cares to know the details of European precedents. We may add that all measures have been converted into English denominations.

NEW TRADE LITERATURE.

JNO. T. BURR & SON, Brooklyn, N. Y. Illustrated catalogue of the "Burr" cold saw, with full description of same.

E. G. SMITH, Columbia, Pa., announces that he wishes to sell his filter business in order to devote all his time to his line of fine tools.

THE BOSTON GEAR WORKS, Boston, Mass. Catalogue "P" of gear specialties for 1903. Bevel, spur and internal gears with teeth planed theoretically correct, also spiral and helical spurs are there listed.

WYMAN & GORDON, Worcester, Mass. "A Short Story of Elias Howe." This is a sketch of the life of the great inventor of the sewing machine. Also leaflet illustrating the drop forgings manufactured.

AMERICAN STEEL & WIRE CO., Chicago and New York. Pocket catalogue, May, 1903, of the "Juniata" horse and mule shoes and toe calks, which are manufactured of iron or steel, are of different weights and for many purposes.

THE CROCKER-WHEELER CO., Ampere, N. J. Pamphlet illustrating the Crocker-Wheeler railway generator. Three fine half-tone views of the field, the armature and the brush rigging are shown, with brief description of each.

THE WILLIAMSON MFG. CO., Bradford, Pa. Folder illustrating and describing the "Williamson" vise. By one motion of the hand, pulling the lever forward, the jaws can be moved to right or left, up or down, forward or backward.

THE C. W. HUNT CO., West New Brighton, S. I. Illustrated circular of coal tubs and contractors' tubs for the prompt handling of coal. They also make a special "side catch" tub for handling gravel, stone, sand, clay, mortar, concrete, etc.

THE YALE & TOWNE MANUFACTURING CO., 9-15 Murray Street, New York. Pamphlet illustrating the "Triplex" hoisting blocks, for use in warehouse, press room, erecting shop, machine shop, boiler works, etc., in fact for all hoisting purposes.

THE EMERSON ELECTRIC MANUFACTURING CO., St. Louis, Mo. Small folder just from the press containing much condensed information about small induction motors. This is to supplement the Emerson bulletins already issued, all of which are sent on request.

THE SAWYER TOOL CO., Fitchburg, Mass. Illustrated price list of fine tools and hardware specialties. This supersedes all previous matter issued by the company and those writing for it should ask for "Catalogue F."

THE R. D. NUTTALL CO., Pittsburg, Pa. Booklet calling attention to the Nuttall motor gears and pinions. This company is occupied with the manufacture of gears only, and the booklet illustrates street railway motor gears from small size to 30 feet in diameter.

THE RAND DRILL CO., 128 Broadway, New York. Circular No. 10 of "Imperial" piston air drills, piston air wood boring machines, pneumatic hammers, etc. Examples of the work done—that is, reaming, tapping, flue rolling and wood boring—are shown, together with the tools used.

THE STANDARD WELDING CO., Cleveland, O. Illustrated catalogue, pocket size, of seamless steel tubing for all purposes. This shows only a part of the large line manufactured. Standard steel rims, clincher rims, bicycle parts are listed, and samples of electric welding are shown.

THE J. MORTON POOLE CO., Wilmington, Del. Circular describing and illustrating the company's new line of vertical boring and turning mills, which are shown in our last number. These are made in the following sizes: 6-foot, 7-foot, 8-foot and 10-foot, and they state that they are preparing to build larger sizes of regular and extension boring mills.

THE JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Booklet entitled "An Index to Find the Fact you Need to Know," meaning, of course, facts about pencils for all possible uses. It explains what pencil is best suited to the work to be done, and no less than 54 pencils are described for merchants, metal workers, office workers, railroad companies, etc.

THE BOSTON GEAR WORKS, Purchase and Pearl Streets, Boston, Mass. Catalogue "P" and price list of gear wheels and gear cutting of every description. This treats of bevel, spur and internal gears with teeth planed, and of spiral and helical spur gears for smooth running or for high speeds. Besides the advertising matter contained herein there is considerable information and a number of tables on gearing, which will prove useful.

THE GRAHAM MANUFACTURING CO., Providence, R. I. Booklet calling attention to the "Universal" jig vise for use in plain and duplicate drilling. The company state that this saves time in the changing of pieces, and the jig attachment furnished enables the operator to drill as accurately as with a special jig. By using a simple drilling plate the vise may be used for drilling several holes in definite relation to one another.

THE EMERSON ELECTRIC MANUFACTURING CO., St. Louis, Mo. Bulletins Nos. 3041, 3042, and 3044, of direct-current power motors, direct-current motors and of polishing and grinding motors respectively, with considerable data regarding each type. The company manufacture alternating-current desk, bracket, ceiling and column fans; direct-current exhaust fans and power motors; alternating current power motors, pressure blowers, forge blowers, water pumps, etc.

THE PITTSBURG BLUEPRINT CO., Pittsburg, Pa. Catalogue of electric blueprinting machine. Type A is the machine with upright wall; type B with tilting wall; type C with upright wall and automatic; type D with tilting wall, and automatic. Self-contained machines, types E. F. G. and H, are shown. The "Imperial" blueprint wringer—an improved apparatus for the purpose—which is driven by a small electric motor is also illustrated. This is built in three sizes, for rolls 34, 40 and 46 inches long.

THE CONSOLIDATED PRESS & TOOL CO., 96-100 N. Clinton Street, Chicago, Ill. Bulletin No. 1 describing a new line of power presses recently gotten out by this company. These are of the inclinable, open-back type, and possess a number of new features which are here described. Various styles and sizes of this machine are made, and the company also build presses for other work, such as wiring, blanking, punching, notching, etc., and special machinery for the manufacture of metal specialties.

THE BILLINGS & SPENCER CO., Hartford, Conn. Pamphlet descriptive of small tools such as sportsmen's knives, magazine screw drivers and knives, adjustable pocket wrenches, combination pliers, an improved key ring, etc.; and drop forgings and machinists' tools. Also leaflets illustrating by line drawings the Lemoine front axle forgings for 1½-inch automobile axle, designed mostly for touring cars of from 12 to 30 horse power. Circular and price list will be furnished on application.

THE NORTHERN ELECTRICAL MFG. CO., Madison, Wis. Crane motor Bulletin No. 32, of steel crane motors specially adapted to the requirements of crane service. This is electrically-driven, doing away with belts, is of the enclosed, dust-proof type, with bosses on the side for conveniently fastening to any required mechanism. The motor and its parts are illustrated and described at length, and on the front page is a view of Machine Shop No. 2 of the Northern Electrical Mfg. Co., showing their crane equipped with these motors. A cut also shows a "Northern" type of geuerator mounted on an Atlas Corliss engine.

THE CINCINNATI MACHINE TOOL CO., Cincinnati, O. Standard size catalogue 1903, of upright drilling and tapping machines. These range from 21 to 42 inches in swing and a number of them are being built with the company's patent geared tapping attachment, by the use of which the operator can tap right and left-hand threads equally well, and which can be disengaged when not required. Among the new things are their motor-driven drills and their drills with compound tables and geared revolving tables. The catalogue is profusely illustrated.

E. G. SMITH, Columbia, Pa., has issued a circular whose purport is that a number of his calipers, all sizes and styles shown in his catalogue, have become slightly shopworn from being exhibited, which he will dispose of at less than actual cost. A few hundred "Which Way" pocket levels only slightly rusted, but which will wear bright if carried in the pocket, are for sale at 25 cents each. Also parallel strips one-half inch square and any length up to thirty inches, can be purchased at 2 cents per inch in length. The circular also shows a combination micrometer which any mechanic can construct himself, either singly or in quantities.

BOYNTON & PLUMMER, Worcester, Mass. Catalogue and price list No. 2 of shaping machines, and upright hand and power drills. The catalogue is illustrated and, it seems to us, covers the line of tools manufactured very thoroughly. Traverse head shapers, upright self-feeding drills, upright bench drills, upright power drills, overhead or hanging drills, horizontal drills, self-feeding swivel clamp drills, bolt cutters, and nut tappers, tire benders and shrinkers, various types of forges, etc., are listed. Twenty-eight pages are devoted to an illustrated list of duplicate parts, for repairs to the company's machines, by the use of which they may be ordered by name or number.

THE AJAX MANUFACTURING CO., Cleveland, O. The "Ajax Brown Book," 1903, of "Ajax" forging machines. The Ajax Company are the sole manufacturers of this machine, which is the invention of Mr. J. R. Blakeslee. It has recently been improved and a number of important features added, and is here illustrated and described, and samples of the work turned out are shown in half-tone views. It is built for work ¾ inch, 1, 1½, 2, 2½, 3, 3½, 4, 5, and 6 inches. Other tools shown are bolt-heading and open die rivet machines; automatic feed rivet machines; forging rolls; bulldozers; hot pressed nut machines; and a multiple spindle drill. Also a special axle machine with large die opening, made in any size. A number of useful tables appear in the back.

THE INTERNATIONAL MINING DIRECTORY, 1903. Price $10.00. This publication, containing 523 pages, gives concise and reliable data regarding location, ownership, management, character of ore, development, equipment, etc., of the principal operating mines and metallurgical plants in Western United States, Mexico, South and Central America, Canada, Africa, Australasia, India, Japan, Korea. The book should prove exceedingly valuable to any interested in the subjects of mining and metallurgy, comprising as it does the names of all the reputable concerns engaged in the operation of mines or in the building of mine machinery. It is published by the Western Mining Directory Company, Denver, Colo., and San Francisco, Cal.

THE NEWTON MACHINE TOOL WORKS, Inc., Philadelphia, Pa. Catalogue No. 36, standard size, of machinery for army, navy, railway and general machine shop equipment; also engineering specialties in metal-working machinery. This is a catalogue of 236 pages, and is most complete. It lists plain milling machines, special milling machines for railway work; ten sizes and varieties of duplex milling machines; vertical slabbing machines; universal milling machines; rotary planing machines, with fixed heads, and swiveling heads; portable combined milling, drilling and boring machines; slotting machines; cold saw cutting-off machines; floor boring machines; a large variety of boring machines. All of these are illustrated, and the nature of the work for which each machine is specially designed is mentioned. A keyseat milling machine is shown, with two spindles, for keyseating shafting, which is an improvement on the usual method of keyseating, and secures a perfect keyway. This method is explained and illustrated in the catalogue.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Armour Institute, Chicago, Ill., have recently issued a catalogue containing much information of interest to those who are giving any attention to correspondence instruction. This method of securing an education is growing more and more popular, filling, we are told, a real want; and the School has, besides its large number of students here, quite a number abroad—even including the Fiji Islands, the Falkland Islands, and 300 students in New Zealand alone. The instruction is under the direction of members of the faculty of Armour Institute of Technology; and Dr. Gunsaulus, president of that Institute, has given the work his enthusiastic support and personal supervision. Due credit for the work covered by correspondence will be given any student who, later, may wish to pursue his studies at Armour Institute. The instruction papers are prepared especially for home study and a true indication of their value is the fact that they are used as text books in some of the universities and other educational institutions of this country. The catalogue contains also a list of the instructors, text-book writers, the Advisory Board, and of the School's graduates.

CHARLES A. SCHIEREN & Co., New York. Illustrated pamphlet entitled "The Art of Tanning and Currying Belt Leather." This is a brief but interesting record of the history of tanning, and gives an account of the art as practiced at the company's "Dixie" tannery, Bristol, Tenn. A description is given of the preparation of the rock oak bark which is used in the process of tanning, a number of half-tones showing the machinery used, etc. Then comes an explanation of the manner in which the hides are prepared for the tanner, one feature being the "stuffing" of the leather with cod oil and pure beef tallow, which preserves the belt and makes it strong and durable. The company state they were the first to make a rivetless belt, joined only by cement, which prevents slipping. Their other products are their "Excelsior" belt, made with an extra dressing that renders it waterproof; their "Electric" belt so treated as to prevent its being damaged by mineral oil; their "perforated electric belt," specially made for all electric light and street railway service; and special wide main driving belts for factories and mills. Some of their larger sizes of belts are: 101 feet long by 60 inches wide; 112 feet by 58 inches, 160 feet by 60 inches, and 165 feet by 78 inches, and are made to stand the most trying service. The company's New York office is 79 Cliff Street.

MANUFACTURERS' NOTES.

MR. P. E. MONTANUS, president of the Springfield Machine Tool Co., Springfield, O., and secretary of the American Tool Builders' Association, is running for Congress in his district.

THE MIAMI VALLEY MACHINE TOOL CO., Dayton, O., are offering a cash prize of $25 for the best design submitted to them on a taper attachment for their new 13½-inch lathe. Details will be furnished on application.

THE DIAMOND DRILL & MACHINE CO., Birdsboro, Pa., have opened an office in Pittsburg, in the Farmers' Bank Building, in charge of G. B. Nutt, the Pittsburg representative of Pilling & Crane; Pilling & Crane being their Pittsburg agents.

THE NILES-BEMENT-POND CO., London, Eng., branch, report that on October 3, Mr. W. S. Accles, their European manager, and Mr. G. T. Reiss, chief engineer at the Hamilton, O., works of their company, were received by the King of Spain, at San Sebastian.

THE INGERSOLL MILLING MACHINE CO., Rockford, Ill., are building a new erecting shop of concrete, 55x200, and 30 feet high in the clear, equipped with a Pawling & Harnischfeger crane, motor drives to all machines, and other modern appliances. The new building, it is expected, will be ready for occupancy in December.

THE REEVES PULLEY CO., Columbus, Ind., are just completing a new pattern shop, 22 x 60 feet, two stories high. Their new foundry is now in operation. They recently had a large order for variable speed transmissions for the new plant of the Alma Portland Cement Co., Wellston, O.

SCHUCHARDT & SCHUTTE, importers of American machine tools, announce that in addition to their houses in Cologne, Berlin, Brussels, Vienna, St. Petersburg, Stockholm, and New York, they have just opened two more branch houses—one in Paris, France, Rue Reaumur 85, and one in Bilboa, Spain, Gran Via 29.

E. W. ROBERTS, designer and consulting engineer, who is well-known to the gas engine trade and is the author of the "Gas Engine Handbook" and other works on gas engines and automobiles, is fitting up a laboratory at Clyde, O., for the testing of gas and gasoline engines and gasoline automobiles, as well as for calorimetry and the analysis of both gas and liquid fuels.

THE HUETTER MACHINE & TOOL CO., 418 So. Pennsylvania Street, Indianapolis, Ind., announce that they have a fine tool plant, equipped with machinery for the manufacture of fine tools, dies, model work and first-class special machinery of all kinds, at reasonable prices. They will be glad to give to anyone interested, prices on anything in their line.

M. H. TREADWELL & Co., Lebanon, Pa., report that the outlook for business is very bright and that their plant will, in all probability, run at its full capacity during the entire winter. Their plant covers seven acres of land and their machine shop is equipped with the latest types of machinery. Since the incorporation of the company in January, 1901, the output has been practically doubled. An electrical department has recently been installed.

JAMES BONAR & Co., Inc., Pittsburg, Pa., have taken over the business heretofore known as James Bonar & Co., and will continue to manufacture and handle a full line of first-class steam appliances. They are erecting a new machine shop and brass foundry for the manufacture of their own specialties and for other machine work. The shop will be equipped with new machinery of modern design, specially adapted to the manufacture of special work.

THE INDIANAPOLIS BLUE PRINT CO., 142-148 N. Illinois Street, Indianapolis, Ind. Illustrated catalogue of architects', engineers' and draftsmen's supplies. This catalogue is very complete, containing 254 pages, and includes everything in this line of goods. An eight-page index appears in the back. The price of the catalogue is 25 cents, but it will be sent prepaid without charge to professional architects and engineers.

THE NORWALK MANUFACTURING CO., Norwalk, O., successors to the Baker & Wilson Machine Co. and the Norwalk Foundry & Machine Co., have issued a preliminary catalogue calling attention to the line of standard bolt cutters and nut tappers and dies which they manufacture. They announce that they are extending this line in many particulars and will illustrate and describe their products as opportunity permits. The pamphlet we have shows their ¾-inch and 1½ and 2-inch bolt cutters with automatic opening head.

THE AMERICAN MACHINERY CO., Grand Rapids, Mich., are just putting on the market a new type of band saw especially designed for patternmakers' work. They have already received orders for these band saws from the N. Y., O. & W. Ry.; the Exeter Machine Co., Pittston, Pa.; the Crocker-Wheeler Co., Ampere, N. J.; the Westinghouse Electric Co., Pittsburg, Pa.; and the Ruemmell, Dawley Manufacturing Co., St. Louis, Mo. They also report a very satisfactory trade on their other larger machines. They have just furnished the Washington Navy Yard, 24-inch hand jointer; the Portsmouth Navy Yard, Oliver universal saw bench; Santa Fe Ry. Co., 4 saw benches, 1 hand jointer and 3 bench trimmers; Erie Ry. Co., saw bench and 2 bench trimmers; Southern Florida Ry. Co., saw bench and hand jointer; Grand Trunk Ry. Co., saw bench, all of which are of the Oliver type.

THE NORTON EMERY WHEEL CO.'S (Worcester, Mass.) employees extended to Mr. Charles L. Allen, the secretary and general manager, a welcome home from his recent European trip on October 8. The entertainment took place in the immense works at Barber's Crossing, which were handsomely decorated with autumn foliage and occasional flags. A heavy silver cup was presented to Mr. Allen who, during the evening, shook hands with every one of the 400 employees. A light lunch and other refreshments were served and there was quite an attractive musical program. Among other features were a boxing match, in which we are told no blood was shed and which afforded much amusement. Also a series of stereopticon views showing Mr. Allen, Mr. Norton, the inventor of the emery wheel, the old time employees and those of the present day, the old shop and the new works—all of which were of considerable local interest.